Fishery Data Series No. 16-50

Ninilchik River Chinook Salmon Stock Assessment and Supplementation, 2010

by

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and

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December 2016

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat or long
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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ABSTRACT

In 2010, the total number of Chinook salmon counted at the Ninilchik River weir was 658 fish, of which 623 were wild and 35 were hatchery-reared. The wild Chinook salmon escapement corresponding to the sustainable escapement goal (SEG) index monitoring period (3 July through 31 July) was 605 fish, which fell within the SEG range of 550–1,300 fish. Based on the dates of the median run times during the SEG index monitoring period, the wild Chinook salmon run was 8 days earlier than the hatchery-reared Chinook salmon run. The dominant age class was ocean age 2 for both wild and hatchery-reared Chinook salmon. No egg takes were conducted in 2010. Stocking goals were met for the Ninilchik River and all Kachemak Bay terminal saltwater fishery locations. The Ninilchik River Chinook salmon supplementation program has continued to provide sport fishing opportunities on the Ninilchik River and terminal saltwater fisheries. Continuation of Chinook salmon assessment at the Ninilchik River weir is recommended to ensure that adequate escapement of wild Chinook salmon is maintained.

Key words: Chinook salmon, *Oncorhynchus tshawytscha*, Ninilchik River, wild, hatchery-reared, supplementation, enhancement, run, escapement, weir, adipose finclip, coded wire tag

INTRODUCTION

Ninilchik River is located on the Kenai Peninsula in the Lower Cook Inlet management area (LCIMA; Figure 1). It is a small (anadromous stream length 81 river kilometers [RKM]), nonglacial stream with extensive wetlands (122 km^2) and no large tributary lakes (Table 1). The Ninilchik River produces annual runs of Chinook (*Onchorhynchus tshawytscha*), coho (*Onchorhynchus kisutch*), and pink (*Onchorhynchus gorbuscha*) salmon; steelhead trout (*Onchorhynchus mykiss*); and Dolly Varden char (*Salvelinus malma*). There are only 3 road-accessible streams in the LCIMA that support Chinook salmon sport fisheries: Ninilchik River, Anchor River, and Deep Creek. Angler effort is focused on the Ninilchik River earlier in the season because water conditions are generally less turbid than those at the Anchor River or Deep Creek. Sport anglers are capable of harvesting a significant portion of the Ninilchik River Chinook salmon run because of its small stream size. From 1999 through 2008, the average annual harvest estimate of Ninilchik River Chinook salmon has averaged roughly 1,400 (ranging from 830 to 1,945). In 2009, the harvest estimate dropped substantially to 203 (Table 2).

In the mid-1980s, the Alaska Department of Fish and Game (ADF&G) Division of Sport Fish (SF) recognized that the Ninilchik River Chinook salmon stock was vulnerable to overharvest from the growing Kenai Peninsula sport fishery. In 1987, SF initiated a supplementation program for the Ninilchik River as a way to create sustainable fishing opportunities through stocking hatchery-reared Chinook salmon smolt (Table 3). As a result of the supplementation program, 2 groups of Chinook salmon (wild and hatchery-reared) now return to the Ninilchik River, which has added an additional level of complexity to the management of Ninilchik River Chinook salmon escapement and harvest.

The following sections summarize the supplementation program and escapement monitoring, the data used to evaluate the sport harvest of hatchery-reared fish, and management strategies (for a more thorough review of these sections, see Kerkvliet and Booz [2010]).

SUPPLEMENTATION

The annual supplementation of Chinook salmon for the Ninilchik River has remained essentially unchanged since 1995, when stocking levels were reduced to 50,000 smolt (from approximately 200,000 smolt) with 100% of the smolt adipose finclipped and coded-wire-tagged (CWT; Appendix A1).

Since 1988, broodstock collection and egg takes have been conducted at a broodstock weir, located at the Brody Road Bridge (RKM 7.7; Figure 2), during the month of July and early August. Only the progeny from wild Chinook salmon broodstock are used for Ninilchik River stockings. From 1988 through 2002, Chinook salmon smolt were stocked as age-0 fish. Since 2003, due to limited hatchery rearing facilities, all stocked Chinook salmon have been overwintered in the hatchery as parr and released in the spring as age-1 smolt. Starting in 1994, additional broodstock from the Ninilchik River was collected to support stocking at the terminal saltwater fisheries in Kachemak Bay at Nick Dudiak Fishing Lagoon on Homer Spit (NDFL; Table 4), Halibut Cove Lagoon (Table 5), and Seldovia Bay (Table 6). A combination of both wild and hatchery-reared Chinook salmon is used as broodstock for the terminal saltwater fisheries.

ESCAPEMENT MONITORING

ADF&G has monitored Chinook salmon escapement in the Ninilchik River since 1962 (Appendix A2). Starting in 1999, all hatchery-reared Chinook salmon returning to the Ninilchik River were marked as smolt with adipose finclips and CWTs. Since then, all weir counts of wild and hatchery-reared Chinook salmon have been differentiated by examining all Chinook salmon at the weir for the presence or absence of an adipose fin. Currently, escapement is monitored at the broodstock weir during an index monitoring period and not over the entire run (Table 7). The Chinook salmon escapement is calculated by removing the holding and egg-take mortalities from the Chinook salmon weir count. On average (1999–2005, when the weir was operated over the entire Chinook salmon run), 65% of the total wild Chinook salmon weir escapement above RKM 7.7 is counted during the index monitoring period (Table 8). This index fails to account for spawning below the weir, which may consist of approximately 35% of the total spawning escapement based on aerial survey data (Marsh memorandum[1]).

ESCAPEMENT GOAL

The sustainable escapement goal (SEG) range for wild Ninilchik River Chinook salmon is 550–1,300 fish during the index monitoring period (3–31 July; Appendix A3). This SEG was calculated using the percentile method (Bue and Hasbrouck *Unpublished*)[2] and is based on the wild escapement above the weir during the index monitoring period from 1999 through 2007 (Otis and Szarzi 2007).

SPORT HARVEST

Monitoring the Chinook salmon sport harvest at the Ninilchik River has become more complicated since the inception of the supplementation program (Appendix A1). Since 1977, ADF&G has conducted the Alaska Statewide Harvest Survey (SWHS) to estimate, by area and by fishery, the participation, harvest (fish kept), and catch (fish harvested plus fish released) of sport-caught species (Table 2, Figure 3). Unfortunately, the SWHS only reports total estimates and does not provide the stock composition (wild vs. hatchery-reared) of the Ninilchik River Chinook salmon harvest. From 1991 through 2006, periodic assessment of the hatchery-reared contribution to the sport harvest has been conducted with creel and sport harvest surveys. During

[1] L. E. Marsh. *Unpublished*. 1997 memorandum to B. Clark, ADF&G, on preliminary evaluation of the stocking program at the Ninilchik River. Referred to as the *Marsh memorandum*.

[2] Bue, B. G., and J. J. Hasbrouck. *Unpublished*. Escapement goal review of salmon stocks of Upper Cook Inlet. Alaska Department of Fish and Game, Report to the Alaska Board of Fisheries, November 2001 (and February 2002), Anchorage.

runs from high stocking years (1990–1998), these surveys found over 50% of the harvest was hatchery-reared fish (Boyle and Alexandersdottir 1992; Boyle et al. 1993; Balland et al. 1994; Marsh 1995; Marsh memorandum). In 2006, the hatchery-reared percentage of the Chinook salmon harvest during the 3 regulatory 3-day weekend fishery was 39% (Booz and Kerkvliet 2011a).

MANAGEMENT

The sport fishery regulations for Ninilchik River Chinook salmon are designed to conservatively manage for the sustainability of the wild stock. The regulations restrict harvest opportunity by limiting the area open to fishing to the lower 3.2 RKM of the river (to protect the Chinook salmon spawning area) and by limiting fishing openings to 3 consecutive 3-day weekends (Saturday through Monday) beginning on Memorial Day weekend. Starting in 2008, the regulatory Chinook salmon sport fishery in the Ninilchik River includes opportunity to harvest only hatchery-reared Chinook salmon in the lower 3.2 RKM of the river from 1 July through 31 December.

Management of Chinook salmon in the Ninilchik River has been refined since the inception of the supplementation program with a more directed focus towards maximizing the harvest of hatchery-reared fish (Appendix A4). From 1991 through 2001, SF has periodically issued Emergency Orders (EOs) to increase the number of fishing days for both wild and hatchery-reared Chinook salmon. Starting in 2002, EOs increased fishing days for hatchery-reared fish only.

In 2004, the Alaska Board of Fisheries (BOF) adopted a regulation that increased the daily bag limit for Ninilchik River Chinook salmon from 1 to 2 of which no more than 1 fish could be a wild Chinook salmon. The intent of this regulation was to increase the harvest of hatchery-reared Chinook salmon.

This report is part of a continuing series designed to provide information to evaluate the Ninilchik River Chinook salmon supplementation program and to ensure that the wild Chinook salmon escapement at the Ninilchik River is managed according to the *Policy for the Management of Sustainable Salmon Fisheries* (Alaska Administrative Code 5AAC 39.222) and the *Policy for Statewide Salmon Escapement Goals* (5AAC 39.223).

OBJECTIVES

The objectives of this study were as follows:

1) Census the Ninilchik River wild and hatchery-reared Chinook salmon run[3] at RKM 7.7 from 3 July through 31 July 2010.
2) Census the Ninilchik River wild and hatchery-reared Chinook salmon sex composition at RKM 7.7 from 3 July through 31 July 2010.
3) Estimate the Ninilchik River wild and hatchery-reared Chinook salmon age composition at RKM 7.7 from 1 July through 31 July 2010 such that the estimates of each group are within 10 percentage points[4] of the true values 95% of the time.

[3] In 2010, the run count was equal to the escapement count. In other years when egg takes were conducted, escapement was calculated by removing the mortality associated with egg takes from the weir count.

TASKS

1) Release hatchery-reared Ninilchik River Chinook salmon smolt in May and June 2010: approximately 50,000 smolt at Ninilchik River; 210,000 smolt at NDFL; 105,000 smolt at Halibut Cove Lagoon; and 105,000 smolt at Seldovia Bay.
2) Estimate the within-reader variability of age estimates.
3) Estimate the wild and hatchery-reared Ninilchik River Chinook salmon length-at-age.
4) Gather daily stream temperature, discharge, and tide height data from other agencies.

METHODS AND ANALYSIS

ESCAPEMENT MONITORING

Weir Counts

A fixed-picket weir (Figure 4) was installed approximately 7.7 RKM (Figure 2) from the mouth of the river on 1 July at 2:30 PM and operated through 1 August. The weir was visually inspected on a daily basis for holes to ensure no fish could migrate past undetected. The gate to the live box was opened daily at approximately 8:00 AM and closed around 11:00 PM. Technicians periodically checked the live box and processed all fish as quickly as possible to avoid impeding the migration. All captured fish were identified to species and tallied for daily weir counts. All Chinook salmon that entered the live box were examined for an adipose finclip to identify origin (wild or hatchery-reared) and then given an upper caudal finclip to prevent double sampling in the event of a weir failure.

Escapement

In 2010, no egg takes were conducted due to the shifting of Chinook salmon production to the new William Jack Hernandez Sport Fish Hatchery (WJHSFH) in Anchorage. With the new hatchery and increased production, Chinook salmon are released as age-0 smolt instead of overwintering in the hatchery and stocked as age-1 smolt. The increase in production achieved stocking goals for 2011 without the need for conducting egg takes in 2010. No egg takes were conducted in 2010, and therefore the Chinook salmon escapement was equal to the weir count. In other years when egg takes were conducted, escapement was calculated by removing the mortality associated with egg takes from the weir count.

Only the wild Chinook salmon escapement count was used to determine if the SEG was met. The 2010 wild and hatchery-reared percentages of the total Chinook salmon escapement during the SEG index monitoring period were compared to their respective historical averages.

SEG Period Run Timing

The run timing of wild and hatchery-reared Chinook salmon relative to the SEG monitoring period (3–31 July) was plotted as cumulative percentages. The median run timing date (date nearest to 50% of the cumulative count) was identified for each component of the run. The 2010 wild and hatchery-reared cumulative plots were compared to each other and to their respective average (1999–2009) cumulative plots to observe any differences in run timing.

---

[4] Within d percentage points of the true value A% of the time implies $P(p_i - d/100 \le \hat{p}_i \le p_i + d/100) = A/100$ for all i, where p_i denotes population age proportion for age class i.

WATER TEMPERATURE, DISCHARGE, AND TIDE

Cook Inletkeeper (CIK), a citizen-based nonprofit group, collected water temperature in degrees Celsius once every 15 minutes using a temperature logger at their NR-2 site (described in Mauger 2005). The NR-2 site (RKM 13.7) is located approximately 6.0 RKM (Figure 2) from the Ninilchik River weir site. The reported daily mean, minimum, and maximum temperatures were calculated from all 15-minute temperature readings recorded throughout each day.

The discharge data presented in this report were collected by the National Weather Service, Alaska Pacific River Forecast Center (RFC) at the Beach Access Road Bridge (RKM 0.9; Figure 2). RFC contracted a local citizen to collect a daily stage reading (in feet) at approximately the same time each day (~1900 hours) using a wire weight gauge. Collected stage readings were then converted to discharge in cubic feet per second (ft^3/s) using a rating curve of previous discharge and stage measurements from the same Ninilchik River site. The RFC data are not formally published and should be considered provisional.

The predicted daily high and low tide heights for the Ninilchik River were taken from the Cape Ninilchik location on the National Oceanic and Atmospheric Administration (NOAA) tides and currents website at http://tidesandcurrents.noaa.gov. High tide heights were calculated by adding 1.2 ft to the Seldovia reference station heights. No correction factor was used for low tide heights.

The correlations of daily Chinook salmon (wild and hatchery-reared) weir counts during the SEG index monitoring period with daily river water temperatures, discharge, and tide heights were examined with Pearson's correlation coefficient (r). The hypothesis that $r = 0$ was tested.

BIOLOGICAL SAMPLES

Age composition sample-size goals for wild (135 fish) and hatchery-reared (70 fish) Chinook salmon were calculated by combining a finite population correction factor (Cochran 1977) with the sample size determined under the assumption of multinomial sampling (Thompson 1987), assuming an average run size during weir operation dates and assuming 20% of the scale samples for age estimates were unreadable.

Sex was determined for all Chinook salmon by observing sexual characteristics such as a protruding ovipositor on females and a developing kype on males. The sex ratio of each of the wild and hatchery-reared components of the escapement is therefore known without error.

Age and length sampling for wild Chinook salmon was conducted every other day throughout the weir operation by applying a sampling rate of 0.196 to the cumulative wild Chinook salmon weir count since the last sampling event and rounding up to the nearest whole number. The sampling rate was estimated by dividing the wild Chinook salmon sampling goal (135 fish) by the 2007–2009 average wild weir counts during weir operation dates (690 fish). Wild Chinook salmon sampling started immediately in the morning when the live box was opened, and sampling was continued until the sampling number was met. In recent years, the hatchery-reared Chinook salmon weir counts have been less than 100 fish annually, and for simplicity, every hatchery-reared Chinook salmon was sampled for age and length.

For age sampling, 3 scale samples were collected from the preferred area (Welander 1940) on the fish's left side and were mounted directly to gum cards. Length was measured from the mid eye to tail fork (METF) to the nearest 5 mm. All wild and hatchery-reared Chinook salmon less than or equal to 550 mm METF were tallied as jacks (ocean-age-1 males). Some jacks are greater

than 550 mm and some age-2 fish are less than 550 mm, so the length-based tally was considered an estimate of the number of jacks. The estimated jack abundance (through scale age estimates) was compared with this length-based estimate.

The scale gum cards were pressed into acetate using a Carver press at 99°C and 22,500 pounds per square inch (psi) for approximately 2.5 minutes. Scales were read using a microfiche reader and aged with methods described by Mosher (1969). Age estimates were produced independently of size, sex, and other age estimates. Scale samples were aged twice to estimate within-reader variability. All scale samples that had conflicting ages for the 2 estimates were re-aged to produce a resolved age, which was used for composition and abundance estimates. The scale reader had previous experience aging both juvenile and adult salmonid scales and other calcified structures, including scale samples from Ninilchik River Chinook salmon.

In previous years, the age-sex composition estimates for wild and hatchery-reared Chinook salmon were calculated without incorporating the known sex composition (Balland and Begich 2007; Begich 2006, 2007; Kerkvliet 2008). In some years, such as 2007, unconditional sampling estimates of the number of males were substantially greater than the census of males (Booz and Kerkvliet 2011b). The reason that males were overrepresented in the samples is unknown. To reduce bias associated with possible sex-selective sampling, the age-sex composition estimates for wild Chinook salmon were calculated by incorporating the known sex composition as described in Equations 1 through 12 below. Because all hatchery-reared Chinook salmon were sampled for age, any selectivity bias was eliminated.

Although an attempt was made to sample all hatchery-reared Chinook salmon, we were unable to obtain a census of sex or age. The following formulas were used to estimate age and sex compositions for each component (wild and hatchery-reared) of the Chinook salmon run.

The proportion by sex to the weir count is known and was calculated as follows:

$$p_i = \frac{x_i}{N} \tag{1}$$

where

x_i = number of fish of sex class i in N, and

N = number of fish in weir count (run).

The proportion of fish of age j given sex i was estimated as follows:

$$\hat{p}_{j|i} = \frac{x_{ij}}{n_i} \tag{2}$$

where

x_{ij} = number of fish of age class j in n_i, and

n_i = number of fish of sex class i in fish sampled for age

with variance estimated as follows:

$$\text{var}(\hat{p}_{j|i}) = \frac{N_i - n_i}{N_i} \frac{\hat{p}_{j|i}(1-\hat{p}_{j|i})}{n_i - 1}. \quad (3)$$

Abundance of fish of age *j* given sex *i* was estimated as follows:

$$\hat{N}_{j|i} = \hat{p}_{j|i} N_i \quad (4)$$

with variance estimated as

$$\text{var}(\hat{N}_{j|i}) = N_i^2 \text{var}(\hat{p}_{j|i}). \quad (5)$$

The proportion of fish in age class *j* and sex class *i* in the weir run was estimated as follows:

$$\hat{p}_{ji} = \frac{\hat{N}_{j|i}}{N} \quad (6)$$

with variance estimated as

$$\text{var}(\hat{p}_{ji}) = \frac{1}{N^2} \text{var}(\hat{N}_{j|i}). \quad (7)$$

The abundance of fish in age class *j* in the run was estimated by summing over sex *i*:

$$\hat{N}_j = \sum_{i=1}^{2} \hat{N}_{j|i} \quad (8)$$

with variance estimated as

$$\text{var}(\hat{N}_j) = \sum_{i=1}^{2} \text{var}(\hat{N}_{j|i}). \quad (9)$$

The proportion of fish in age class *j* in the run was estimated as follows:

$$\hat{p}_j = \frac{\hat{N}_j}{N} \quad (10)$$

with variance estimated as

$$\text{var}(\hat{p}_j) = \frac{\text{var}(\hat{N}_j)}{N^2}. \quad (11)$$

Chi-square tests were used to identify differences in the age compositions between males and females and between wild and hatchery-reared Chinook salmon. Wild and hatchery-reared Chinook salmon mean length-at-age and its variance were estimated using standard summary statistics. The 2010 wild and hatchery-reared Chinook salmon mean lengths-at-age were compared using 2-tailed *Z* tests.

The within-reader variability of scale age estimates was calculated using a coefficient of variation (CV) expressed as the ratio of the standard deviation over the mean age (Campana 2001):

$$CV_j = 100\% x \frac{\sqrt{\sum_{i=1}^{R} \frac{(X_{ij} - X_j)^2}{R-1}}}{X_j} \tag{12}$$

where

X_{ij} = the ith age estimate of the jth fish,

X_j = the mean age estimate of the jth fish, and

R = the number of times each fish is aged.

For each sex, age, or wild vs. hatchery-reared group, the CV_js were averaged across all fish (j) in the group to produce a mean CV.

STOCKING

Smolt Release and Marking

The Chinook salmon eggs used for stocking were reared to smolt at the Fort Richardson hatchery. All hatchery-reared Chinook salmon smolt released at the Ninilchik River were thermal marked, adipose finclipped, and injected with a CWT by hatchery personnel. All smolt released at Halibut Cove Lagoon, Seldovia Bay, and the NDFL were only thermal marked. Prior to stocking at all locations, hatchery personnel also assessed the average weight of smolt. Average length and CWT losses were assessed prior to release for the Ninichik River stocking. The Statewide Stocking Plan (Loopstra 2007) was used to plan and schedule the release of LCIMA smolt.

LOCAL GUIDE HARVEST

During the inriver sport fishery, a volunteer sport fishery guide noted the catch and harvest of wild and hatchery-reared Chinook salmon in the freshwater sport fish guide logbook[5] for each guided trip. The hatchery-reared percentage of Chinook salmon caught and harvested was estimated for each regulatory weekend and 2 four-day periods in July during the regulatory hatchery-reared fishery. The percentage of hatchery-reared and wild Chinook salmon in the catch and harvest for each guided trip was estimated as a binomial proportion (Cochran 1977):

$$\hat{p}_{jk} = \frac{n_{jk}}{n_k} \tag{13}$$

where the subscript j represents either wild or hatchery-reared salmon and subscript k represents either catch or harvest.

[5] 2006 Freshwater Sport Fish Guide Logbook and Vessel Registration. ADF&G, Division of Sport Fish, Anchorage. A logbook is required by all sport fish charter and guide services operating in Alaska. It is the responsibility of the business owner to obtain the logbook and assure that all data for fishing activities are submitted to ADF&G.

The variance was estimated as follows:

$$\text{var}(\hat{p}_{jk}) = \frac{\hat{p}_{jk}(1-\hat{p}_{jk})}{n_k - 1}. \quad (14)$$

No finite correction factor was used because the inriver population size during each guided trip was unknown. Chi-square tests were used to identify differences in the proportions of hatchery-reared fish in the Chinook salmon harvest over the regulatory sport fishery. The 2010 point estimates of catch and harvest compositions were compared to similar logbook-based estimates for the same guide in 2006 through 2009, but no statistical analyses were performed.

RESULTS

ESCAPEMENT MONITORING

Weir Counts

In 2010, the total number of Chinook salmon counted through the Ninilchik River weir from 1 June through 1 August was 658 fish of which 623 were wild and 35 were hatchery-reared (Table 7, Appendix B1). The Chinook salmon escapement was 95% (623/658) wild (Table 7). In 2010, very few other species of fish were observed at the weir (Table 9).

Escapement

During the SEG index monitoring period (3–31 July), 605 wild and 34 hatchery-reared Chinook salmon escaped above the weir (Table 8). The wild Chinook salmon escapement exceeded the lower end of the SEG by 55 fish (SEG range is 550 to 1,300). The contribution of wild Chinook salmon to the total escapement during the SEG index monitoring period was 94.7% (605/639) (Table 8; Figure 5). Wild and hatchery-reared escapement counts were lower than the 2006–2009 escapement average for the SEG index monitoring period by 63 and 62 fish, respectively.

SEG Period Run Timing

The 2010 cumulative SEG period run-timing plots of wild and hatchery-reared Chinook salmon showed that both components of the run were later than average through 12 July (Figure 6). The 2010 wild Chinook salmon median date (17 July) was the same as the 1999–2009 average. The 2010 hatchery-reared Chinook salmon median date (25 July) was 5 days later than the 1999–2009 average.

Water Temperature, Discharge, and Tides

In 2010, the average water temperature recorded during the SEG index monitoring period was 1 degree below the recent 11-year average (1999–2009; Table 10, Appendix C1). During the SEG index monitoring period, the average discharge was 107 cfs (range 71–229 cfs), which was above the recent 11-year average (Table 10, Appendix D1). Average stage height recorded during the SEG index monitoring period (3.44 ft) was above the recent 11-year average of 3.28 ft (1999–2009; Table 10, Appendix D2). Between 3–31 July, the daily average high tide height ranged from 13.7 to 21.8 ft and averaged 18.0 ft (calculated from Appendix E1). The daily average low tide height ranged from −4.8 to +5.3 ft and averaged +1.6 ft. Approximately 35% of the total Chinook salmon weir count occurred during the peak of the larger tide series from 12 to 14 July and approximately 29% of the total Chinook salmon weir count was counted on

25–26 July when discharge started to increase to the peak flows of the index monitoring period (Figure 7, Appendices B1, D1, and E1).

No correlations were found between daily weir counts and average water temperature ($r = 0.073$, df = 28, $P = 0.71$) or discharge ($r = -0.011$, df = 28, $P = 0.95$) during the SEG index monitoring period (Figure 7). Daily counts were positively correlated with the daily average high tide height ($r = 0.489$, df = 28, $P = 0.007$).

BIOLOGICAL SAMPLES

A total of 112 wild and 35 hatchery-reared Chinook salmon were sampled for age and length. The wild Chinook salmon sampling goal was achieved and all hatchery-reared Chinook salmon were sampled for age and length data. Approximately 12% of wild and 14% of hatchery-reared scale samples were not readable due to regeneration or poor mounting (Table 11). Of the samples collected, 99 wild and 30 hatchery-reared samples were aged. Ocean-age-2 was the dominant age class for both wild (52.2%, SE 3.7%) and hatchery-reared (46.9%, SE 3.3%) Chinook salmon (Table 11, Figure 8). Ocean-age-3 was the dominant age class for both wild and hatchery-reared females. The majority of males were ocean-age-2 for both wild and hatchery-reared Chinook salmon. Statistically significant differences were detected between the wild and hatchery-reared Chinook salmon age composition ($\chi^2 = 8.4$, df = 3, $P = 0.038$), and between the age composition for wild and hatchery-reared males ($\chi^2 = 7.7$, df = 2, $P = 0.022$). Data for females were too sparse to conduct a test of age composition between hatchery and wild fish.

The wild jack Chinook salmon weir census (47 fish) was within the 95% CI for the estimate of ocean-age-1 Chinook salmon from the ASL sample (26 fish, SE 11.7) (Table 11). The hatchery-reared jack Chinook salmon weir census (5 fish) was similar to the estimated abundance from the ASL samples (7 fish, SE 1.0).

The overall mean length of wild Chinook salmon (684 mm) was larger than the overall mean length of hatchery-reared Chinook salmon (638 mm; Table 11; $Z = 2.11$, $P = 0.035$). Mean lengths were different between wild and hatchery-reared males (649 mm vs. 606 mm, respectively; $Z = 4.53$, $P < 0.001$), and between wild and hatchery-reared females (769 mm vs. 746 mm, respectively; $Z = 3.33$, $P < 0.001$).

The coefficient of variation (CV, Equation 12) of all scale age estimates was 2.0%. The CVs of scale age estimates for wild and hatchery fish were 1.9% and 2.4%, respectively.

STOCKING

Smolt Release and Marking

The stocking goal[6] was reached for the Ninilchik River and the terminal saltwater fisheries (Tables 3–6). In 2010, Chinook salmon smolt releases were apportioned between the Ninilchik River and 3 terminal saltwater fisheries as follows: 58,297 smolt were stocked at Ninilchik River; 213,503 (105,797 + 107,706) smolt at NDFL; 111,134 smolt at Halibut Cove Lagoon; and 114,421 smolt at Seldovia Bay. In 2010, the average lengths and weights of Chinook salmon smolt stocked in the Ninilchik River (92.7 mm, 9.4 g) were below their respective averages from recent years (Table 3). The average weight of Chinook salmon smolt stocked at NDFL (10.7 g,

[6] Hatchery-reared Ninilchik River Chinook salmon smolt stocking goals: Ninilchik River (50,000 smolt), NDFL (210,000 smolt), Halibut Cove Lagoon (105,000 smolt), and Seldovia Bay (105,000 smolt).

weighted average of 2 stockings), Halibut Cove Lagoon (11.2 g), and Seldovia Bay (10.1 g) were less than their respective weight averages from recent years (Tables 4–6).

LOCAL GUIDE HARVEST

The percentage of hatchery-reared Chinook salmon in the catch and harvest recorded in freshwater sport fish guide logbooks was 19.5% and 58.8%, respectively (Table 12). The catch rate peaked at 1.43 Chinook salmon per angler-day (53/37) during the first 5 days of the July fishery. The 2010 hatchery-reared percentage of the Chinook salmon catch in the sport fishery (19.5%) was below the 2006–2009 average of 23.5% but no statistical analyses were used to compare the averages.

DISCUSSION

The 2010 Ninilchik River wild Chinook salmon escapement during the SEG monitoring period (605 fish) met the lower bound of the SEG (550 fish) for the second time in the last 4 years (Table 8). The 2010 Chinook salmon run timing during the SEG period suggests that the weir was installed prior to the start of the run at the weir site. The daily counts of Chinook salmon at the end of the weir operation suggest that there was still a significant number of Chinook salmon moving past the weir site. The wild Chinook salmon weir count during the SEG period was below all SEG counts from 1999 to 2008, but was an improvement over 2009 SEG count (551; Table 8).

The 2010 hatchery-reared Chinook salmon cumulative weir count was the lowest annual count observed at the weir site since the project's inception (Table 8). Poor hatchery-reared Chinook salmon runs were also observed at the Kachemak Bay stocking locations, which suggests poor ocean survival for the 2006–2009 stockings that composed the 2010 run. Like the 2009 run, the estimated age composition of the 2010 run showed a large reduction in the numbers of ocean-age-3 fish for both the wild and hatchery-reared components compared to previous years (Table 13).

In 2010, the sex composition of the Chinook salmon weir counts throughout the run suggest that the run was not complete prior to the removal of the weir. It was noted that both the wild and hatchery-reared Chinook salmon runs were composed of a higher percentage of males than any other year at the weir (also see Table 11 and similar tables in Balland and Begich [2007]; Begich [2006, 2007]; Booz and Kerkvliet [2011a, 20011b, 2011c, 2012]; Kerkvliet [2008]; Kerkvliet and Booz [2010]). In both 2008 and 2009, the beginning of the Chinook salmon run was dominated by males but then shifted to almost entirely females by the end of the run and in 2010, the wild Chinook salmon run had a higher percentage of females during the last week, but males were still prevalent (M. Booz, Fisheries Biologist, ADF&G, Homer, unpublished data). These observations suggest that there was still a significant number of Chinook salmon moving past the weir site. It is likely that the weir would have been operated into August if egg takes had been conducted. Ultimately, operating the weir over the entire Chinook salmon run to monitor escapement would eliminate the influence of run timing on the assessment of escapement. When the weir was operated over the entire run (1999–2005), on average 95% of the run was counted between 15 June and early August (M. Booz, Fisheries Biologist, ADF&G, Homer, unpublished data). This schedule requires operating the weir for only an additional 2 weeks longer than the current operation dates. The sex ratio, daily counts, and maturity of Chinook salmon should be used to assess when the run is nearing the end.

Age composition and average length-at-age data for wild and hatchery-reared Chinook salmon show that the hatchery-reared fish are younger and smaller. Differences in age-length sampling (subsampling for wild fish vs. sampling all for hatchery-reared fish), and probable size and sex selectivity biases associated with subsampling, mean that the statistical tests of differences in age composition should be viewed with caution. Chi-square tests within sex are more robust, but in 2010 there were so few hatchery-reared females counted at the weir that associated chi-square tests were not possible. When the run size of the hatchery-reared component dictates that subsampling is required, then subsampling should be conducted in a similar fashion to the wild component. Continuing to census the sex composition is recommended because it avoids sex selectivity and reduces bias associated with estimates of age composition from sampling.

Using the "less than or equal to 550 mm METF" criterion for wild jacks made counting these fish problematic in 2010. We found overlap in the lengths of some age-2 wild fish that were also less than or equal to 550 mm METF. Some of this overlap may be due to measurement error in the field and aging error in the lab, but it is likely that part of the size overlap between age-1 and age-2 fish is real. Size overlap also occurs between all other ages (i.e., age-3 fish overlap in size with both age-2 and age-4 fish). In 2010, there were 5 age-2 wild fish out of 50 age-2 fish (10%) that were less than or equal to 550 mm METF. All 4 age-1 wild fish were less than or equal to 550 mm. The results suggest that counting "jacks" as defined by length does not produce a census as originally intended. It is recommended that length-based age assignments be used with caution and that length-age plots be used to ascertain whether length-based age assignments are useful. In 2010, the wild length-based jack count was higher than the age composition estimate for jacks; this observation suggests that there was size bias in the subsampling of wild males. Length-based counting of jacks should be continued in future years of monitoring, while keeping in mind the effects of overlap in the count.

The 2010 SWHS estimate of Chinook salmon harvested in the Ninilchik River was well below average and similar to the 2009 estimate (Table 2). Based on the SWHS Chinook salmon catch estimate, only 26% of the catch was harvested. This low percentage is probably due to anglers catching and releasing wild Chinook salmon during the July hatchery-only fishery. The estimate of angler-days was roughly half the 1999–2009 average. The decline in effort was probably due to a combination of a poor Chinook salmon run and the emergency order that restricted the sport fishery for the second and third 3-day weekend sport fishery (Appendix A4).

It was fortunate that no egg takes were conducted in 2010. It is very likely that an egg take would have compromised our ability to meet the SEG, especially because the low number of hatchery-reared Chinook salmon would have meant most of the females used in the egg take would have been wild. The lower end of the SEG was only exceeded by 55 fish, which is well below the roughly 115 females required to meet egg-take goals. The 2010 Chinook salmon run highlights the influence egg takes can have on meeting the SEG on the Ninilchik River during low run size years.

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TABLES

Table 1.–Characteristics of Ninilchik River drainage.

Drainage characteristics	Total
Watershed area	347.9 km^2
Wetland area	122.5 km^2
Percent wetlands	35.2 %
Stream length	260.7 RKM
Anadromous stream length	81.0 RKM
Percent mapped anadromous	31.1%

Source: S. Baird, Kachemak Bay Research Reserve, Homer, AK, unpublished 2006 data.
Note: "RKM" means river kilometers.

Table 2.–Statewide Harvest Survey estimates of angler effort and Chinook salmon harvest and catch compared to the number of days open to fishing for Ninilchik River Chinook salmon, 1977–2010.

			Chinook salmon							
	Angler effort (days fished) [a]		Harvest			Catch [b]				
Year	Estimate	SE	Estimate	SE	Percent jack [c]	Estimate	SE	Percent jack [c]	Percent hatchery harvest [d]	Days open to fishing [e]
1977	11,350	–	1,168	–	ND	ND	–	ND	NA	8
1978	14,173	–	1,445	–	ND	ND	–	ND	NA	9
1979	18,282	–	1,493	–	ND	ND	–	ND	NA	9
1980	19,706	–	723	–	ND	ND	–	ND	NA	9
1981	14,184	–	1,523	–	11.0	ND	–	ND	NA	9
1982	11,806	–	1,240	–	14.9	ND	–	ND	NA	9
1983	9,458	–	871	–	7.8	ND	–	ND	NA	9
1984	10,122	–	648	–	20.9	ND	–	ND	NA	9
1985	10,213	–	983	–	12.9	ND	–	ND	NA	9
1986	9,250	–	420	–	14.1	ND	–	ND	NA	9
1987	13,329	–	1,112	–	2.2	ND	–	ND	NA	9
1988	12,533	–	795	–	7.6	ND	–	ND	NA	9
1989	9,997	–	744	–	42.8	ND	–	ND	ND	9
1990	8,323	–	693	–	16.9	1,598	–	16.4	ND	9
1991	19,640	–	3,123	–	13.4	5,260	–	11.5	77	12
1992	27,816	–	5,316	–	8.6	11,425	–	17.4	57	19
1993	20,466	–	4,235	–	9.2	9,491	–	11.3	50	23
1994	21,827	–	3,108	–	ND	5,482	–	ND	45	23
1995	16,160	–	2,451	–	ND	4,313	–	ND	50	23
1996	11,445	1,034	2,401	289	ND	7,481	1,389	ND	50	19
1997	11,064	718	3,263	309	ND	6,879	868	ND	ND	9
1998	10,994	1,871	1,453	179	ND	3,395	538	ND	ND	9
1999	15,344	2,493	1,945	260	ND	4,153	616	ND	ND	9
2000	12,432	1,514	1,782	218	ND	4,648	582	ND	49	9
2001	10,602	1,137	1,399	204	ND	3,014	496	ND	51	12
2002	9,572	1,169	830	180	ND	2,180	418	ND	ND	12
2003	9,843	1,148	1,452	245	ND	4,205	887	ND	ND	26
2004	10,500	1,464	1,240	224	ND	2,961	ND	ND	ND	55
2005	9,003	1,540	1,342	241	ND	2,042	420	ND	ND	9
2006	9,620	1,092	1,329	229	ND	3,004	509	ND	≥39 [f]	40
2007	10,211	1,101	1,575	304	ND	4,774	1,108	ND	ND	58
2008	8,158	1,262	976	296	22.5	2,090	493	15.3	ND	23

-continued-

Table 2.–Part 2 of 2.

Year	Angler effort (days fished) [a] Estimate	SE	Chinook salmon Harvest Estimate	SE	Percent jack [c]	Catch [b] Estimate	SE	Percent jack [c]	Percent hatchery harvest [d]	Days open to fishing [e]
2009	7,687	1,806	203	61	17.2	560	183	19.1	ND	23
2010	5,296	834	358	113	25.4	1,371	405	18.5	ND	23
Average										
Pre-stocking (1977–1990)	12,338		990			1,598				
High stocking (1991–1998)	17,427		3,169			6,716			55	
Low stocking (1999–2009)	10,270		1,279			3,057			50	

Source: Statewide harvest survey estimates gathered from the published reports for each year. Alaska Sport Fishing Survey database [Internet]. 1996– . Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish. Available from: http://www.adfg.alaska.gov/sf/sportfishingsurvey/.

Note: Standard errors were calculated using the bootstrap method. Because the empirical distribution of derived confidence intervals for these estimates is not symmetrical, valid confidence intervals cannot be obtained directly. Standard errors for estimates were not calculated until 1996.

Note: "NA" means not applicable, "ND" means no data, and an en dash means the value cannot be calculated due to limitations of the data.

[a] The estimate for days fished are for all fish during the entire season, not just for Chinook salmon.

[b] Catch is defined as the number of fish caught-and-released and harvested. Estimates from Gretchen Jennings, project manager, Alaska Statewide Harvest Survey unpublished data, ADF&G, Division of Sport Fish, Anchorage.

[c] The percentage of the total harvest that is less than 20 inches. From 1981 through 1993 and 2008, the SWHS estimates were calculated by large and small Chinook salmon. Prior to 1981 and from 1994 through 2007, the SWHS estimates were for all Chinook salmon regardless size.

[d] Estimated by creel survey 1991–1993, estimated by catch sampling from 1994 through 1996, 2000, 2001, and 2006.

[e] Standardized to end on 14 July. Additional days were added through EO for 1991–2007. Starting in 2008, the regulatory fishery was open from 1 July through 31 December. See Appendix A4.

[f] The 2006 sport harvest survey percent hatchery harvest estimate should be viewed as a minimum because an unknown number of hatchery fish were harvested in an EO fishery that happened after the survey was conducted. See Booz and Kerkvliet (2011a).

Table 3.–Chinook salmon smolt released at Ninilchik River, 1988–2010.

Release year	Release date	Brood year	Number of smolt [a]	Release location [b]	Hatchery	Mark type [c]	Percent adipose finclip [d]	Percent CWT	CWT tag code	Average length (mm)	Average weight (g)
1988	6 July	1987	248,586	Harbor	Ft. Richardson	Ad, CWT	ND	12.5	311762	ND	12.5
1989	1 June	1988	200,203	Harbor	Ft. Richardson	Ad, CWT	ND	9.4	311830	ND	11.8
1990	30 May	1989	215,804	Harbor-Brody	Ft. Richardson	Ad, CWT	ND	18.7	311735	ND	12.8
1991	22 May	1990	87,992	Brody	Ft. Richardson	Ad, CWT	ND	23.9	311934	100	12.0
1992	28 May	1991	132,387	Brody	Ft. Richardson	Ad, CWT	ND	31.2	312104	107	12.5
1993	8 June	1992	184,585	Brody	Ft. Richardson	Ad, CWT	ND	23.3	312159	107	14.7
1994	31 May	1993	201,513	Brody	Ft. Richardson	Ad, CWT	ND	22.6	312318	ND	12.0
1995	31 May	1994	54,662	Harbor	Ft. Richardson	Ad, CWT	ND	99.0	312435	ND	14.1
1996	13 June	1995	51,688	Harbor	Ft. Richardson	Ad, CWT	ND	98.4	312515	ND	12.9
1997	17 June	1996	50,292	Brody	Ft. Richardson	Ad, CWT, TM	ND	99.2	312608	ND	12.0
1998	15 June	1997	48,798	Brody	Ft. Richardson	Ad, CWT, TM	ND	97.3	312635	ND	11.4
1999	15 June	1998	49,853	Brody	Ft. Richardson	Ad, CWT, TM	ND	98.1	310147	104	13.6
2000	2 June	1999	51,298	Brody	Ft. Richardson	Ad, CWT, TM	ND	97.5	310248	96	10.2
2001	13 June	2000	54,770	Brody	Ft. Richardson	Ad, CWT, TM	ND	99.4	310260	104	13.6
2002	14 June	2001	54,631	Brody	Ft. Richardson	Ad, CWT, TM	ND	99.1	310282	101	12.1
2003	12 June	2002	47,997	Brody	Ft. Richardson	Ad, CWT, TM	ND	92.4	310256	105	12.6
2004	12 May	2002 [e]	51,303	Brody	Ft. Richardson	Ad, CWT, TM	ND	92.4	310193	105	12.6
2005	19 May	2003 [e]	55,229	Brody	Ft. Richardson	Ad, CWT, TM	ND	99.9	310318	101	11.9
2006	17 May	2004 [e]	57,537	Brody	Ft. Richardson	Ad, CWT, TM	99.2	99.4	310341	102	12.5
2007	17 May	2005 [e]	56,368	Brody	Ft. Richardson	Ad, CWT, TM	99.5	99.7	310366	92	8.7
2008	15 May	2006 [e]	56,943	Brody	Ft. Richardson	Ad, CWT, TM	99.9	99.5	310372	96	10.3
2009	14 May	2007 [e]	54,797	Brody	Ft. Richardson	Ad, CWT, TM	100.0	99.1	310376	87.6	8.2
2010	13 May	2008 [e]	58,297	Brody	Ft. Richardson	Ad, CWT, TM	ND	98.2	310379	92.7	9.4
Average (1995–2009)			53,078				99.7	98.0		99.4	11.8

Source: Balland and Begich 2007; Begich 2006, 2007; Booz and Kerkvliet 2011a, 2011b, 2011c, 2012; Kerkvliet 2008; Kerkvliet and Booz 2010.

Note: "ND" means no data.

[a] Number released includes smolt that shed coded wire tags.

[b] "Harbor" is Ninilchik River harbor located at the mouth; "Brody" is Brody Road Bridge; "Harbor-Broady" means 50% released in the Ninilchik River harbor and 50% released at Brody Road Bridge.

[c] "Ad" means adipose finclip; "CWT" means coded wire tag; "TM" means thermal mark.

[d] Smolt were checked prior to release for finclip quality starting in 2006.

[e] Smolt were released as freshwater-age-1 fish beginning in 2004.

Table 4.–Chinook salmon smolt released at Nick Dudiak Fishing Lagoon terminal saltwater fishery on Homer Spit, 2000–2010.

Release year [a]	Release date	Brood year	Number of smolt	Hatchery	Mark type	Average weight (g)
2000	31 May	1999	102,243	Elmendorf	None	17.2
2000	7 June	1999	117,741	Elmendorf	None	18.6
2001	25 May	2000	101,799	Elmendorf	None	12.0
2001	8 June	2000	106,263	Elmendorf	None	15.7
2002	30 May	2001	122,444	Elmendorf	Thermal	11.3
2002	6 June	2001	67,582	Elmendorf	Thermal	13.5
2003	28 May	2002	126,229	Fort Richardson	Thermal	11.6
2003	6 June	2002	80,063	Fort Richardson	Thermal	12.4
2004	7 June	2002	95,105	Fort Richardson	Thermal	13.9
2004	10 June	2002	47,932	Fort Richardson	Thermal	13.9
2004	10 June	2003	25,706	Fort Richardson	Thermal	15.6
2005	10 June	2003	111,196	Fort Richardson	Thermal	12.5
2005	13 June	2003	109,626	Fort Richardson	Thermal	13.5
2006	19 June	2004	111,089	Fort Richardson	Thermal	13.1
2006	22 June	2004	112,964	Fort Richardson	Thermal	13.2
2007	11 June	2005	113,636	Fort Richardson	Thermal	11.3
2007	14 June	2005	113,336	Fort Richardson	Thermal	11.2
2008	13 June	2006	110,802	Fort Richardson	Thermal	12.4
2008	17 June	2006	101,339	Fort Richardson	Thermal	10.7
2009	17 June	2007	107,916	Fort Richardson	Thermal	9.4
2009	24 June	2007	56,318	Fort Richardson	Thermal	10.3
2010	7 June	2008	105,797	Fort Richardson	Thermal	10.9
2010	21 June	2008	107,706	Fort Richardson	Thermal	10.4
Average (2000–2009)			204,133			13.0

Source: Balland and Begich 2007; Begich 2006, 2007; Booz and Kerkvliet 2011a, 2011b, 2011c, 2012; Kerkvliet 2008; Kerkvliet and Booz 2010.

Note: All smolt released at Nick Dudiak Fishing Lagoon were produced from the Ninilchik River egg-take project.

[a] Smolt were released as freshwater-age-1 fish beginning in 2004.

Table 5.–Chinook salmon smolt released at Halibut Cove Lagoon terminal saltwater fishery, 1995–2010.

Release year [a]	Release date	Brood year	Number of smolt [b]	Hatchery	Mark type [c]	CWT tag code	Average weight (g)
1995	13 June	1994	37,577	Elmendorf	Ad, CWT	312430	23.6
1996	4 June	1995	97,729	Elmendorf	Ad, CWT	312511	18.5
1997	9 June	1996	78,133	Elmendorf	Ad, CWT	312558	13.4
1998	12 June	1997	65,893	Elmendorf	Ad, CWT	312632	17
1999	1 June	1998	79,221	Elmendorf	NM		16.7
2000	1 June	1999	83,277	Elmendorf	NM		16.5
2001	5 June	2000	106,719	Elmendorf	NM		15.7
2002	28 May	2001	106,279	Elmendorf	TM		12.7
2003	17 June	2002	106,844	Fort Richardson	TM		12.5
2004	4 June	2002	103,771	Fort Richardson	TM		13.6
2005	15 June	2003	112,521	Fort Richardson	TM		13
2006	14 June	2004	117,549	Fort Richardson	TM		11.7
2007	13 June	2005	54,560	Fort Richardson	TM		9.8
2008	19 June	2006	58,674	Fort Richardson	TM		11.6
2009	18 June	2007	35,065	Fort Richardson	TM		9.6
2010	11 June	2008	111,134	Fort Richardson	TM		11.2
Average (1995–2009)			82,921				14.4

Source: Balland and Begich 2007; Begich 2006, 2007; Booz and Kerkvliet 2011a, 2011b, 2011c, 2012; Kerkvliet 2008; Kerkvliet and Booz 2010

Note: All smolt released at Halibut Cove Lagoon were produced from the Ninilchik River egg-take project.

[a] Smolt were released as freshwater-age-1 fish beginning in 2004.

[b] Number released includes smolt that had shed their coded wire tag.

[c] "Ad" means adipose finclip; "CWT" means coded wire tag; "TM" means thermal mark; "NM" means no mark.

Table 6.–Chinook salmon smolt released at Seldovia Bay terminal saltwater fishery, 1996–2010.

Release year [a]	Release date	Brood year	Number of smolt [b]	Hatchery	Mark type [c]	CWT tag code	Average weight (g)
1996	12 June	1995	118,274	Elmendorf	Ad,CWT	312510	18.2
1997	6 June	1996	103,757	Elmendorf	Ad,CWT	312557	13.6
1998	9 June	1997	69,461	Elmendorf	Ad,CWT	312631	13.8
1999	28 May	1998	74,057	Elmendorf	NM		17.6
2000	6 June	1999	68,114	Elmendorf	NM		19.2
2001	7 June	2000	102,793	Elmendorf	NM		14.2
2002	28 May	2001	83,045	Elmendorf	TM		13.4
2003	11 June	2002	107,521	Fort Richardson	TM		11.4
2004	18 May	2003	88,682	Elmendorf	TM		12.9
2005	7 June	2003	114,984	Fort Richardson	TM		13.2
2006	30 May	2004	113,974	Fort Richardson	TM		11.4
2007	5 June	2005	54,276	Fort Richardson	TM		10.5
2008	3 June	2006	54,464	Fort Richardson	TM		12.0
2009	2 June	2007	44,487	Fort Richardson	TM		9.6
2010	17 June	2008	114,421	Fort Richardson	TM		10.1
Average (1996–2009)			85,564				13.6

Source: Balland and Begich 2007; Begich 2006, 2007; Booz and Kerkvliet 2011a, 2011b, 2011c, 2012; Kerkvliet 2008; Kerkvliet and Booz 2010

Note: All smolt released at Seldovia Bay were produced from the Ninilchik River egg-take project.

[a] Smolt were released as freshwater-age-1 fish beginning in 2004.

[b] Number released includes smolt that had shed their coded wire tag.

[c] "Ad" means adipose finclip; "CWT" means coded wire tag; "TM" means thermal mark; "NM" means no mark.

Table 7.–Ninilchik River Chinook salmon weir data, 1989–2010.

Year	Weir operating dates	Chinook salmon run: Component	Chinook salmon run: No. fish	Chinook salmon run: %	Egg take mortality (no. Chinook salmon)	Coded-wire-tagged Chinook salmon: No. fish recovered	Coded-wire-tagged Chinook salmon: No. strays detected [a]	Chinook salmon escapement: No. fish [b]	Chinook salmon escapement: %
1989	4– 25 Jul	Total [c]	254		ND	ND	ND	ND	–
1990	6– 27 Jul	Total [c]	315		ND	ND	ND	ND	–
1991	1–17 Jul	Total [c]	338		ND	12	ND	ND	–
1992	30 Jun–14 Jul	Total [c]	539		ND	59	ND	ND	–
1993	NL		NL	NL	NL	38	1	NL	NL
1994	7–26 Jul	Wild	446	81	ND	NA	NA	–	–
		Hatchery-reared	103 [f]	19	ND	43	0	–	–
		Total [d]	549	100	125	43	0	381	
1995	4 Jul–1 Aug	Wild	725	63	ND	NA	NA	–	–
		Hatchery-reared	425 [f]	37	ND	135	0	–	–
		Total [d]	1,150	100	194	135	0	821	
1996	2–24 Jul	Wild	654	69	ND	NA	NA	–	–
		Hatchery-reared	290 [f]	31	ND	69	0	–	–
		Total [d]	944	100	190	69	0	685	
1997	1 Jul–11 Aug	Wild	579	53	ND	NA	NA	–	–
		Hatchery-reared	517 [f]	47	ND	181	2	–	–
		Total [d]	1,096	100	132	181	2	783	
1998	3 Jul–1 Aug	Wild	536	53	ND	NA	NA	–	53
		Hatchery-reared	466 [f]	47	ND	0	0	–	47
		Total	1,002	100	196	0	0	1,002	
1999	18 May–13 Aug	Wild	1,644	72	68	NA	NA	1,576	73
		Hatchery-reared	641	28	26	42	0	573	27
		Total [e]	2,285	100	94	42	0	2,149	
2000	17 May– 8 Aug	Wild	1,634	66	81	NA	NA	1,553	69
		Hatchery-reared	853	34	60	108	1	685	31
		Total	2,487	100	141	108	1	2,238	
2001	30 May–5 Aug	Wild	1,414	68	175	NA	NA	1,239	70
		Hatchery-reared	673	32	0	130	0	543	30
		Total	2,087	100	175	130	0	1,782	
2002	23 May–11 Aug	Wild	1,516	73	176	NA	NA	1,340	77
		Hatchery-reared	559	27	55	109	0	395	23
		Total	2,075	100	231	109	0	1,735	
2003	16 May–5 Aug	Wild	1,258	75	131	NA	NA	1,127	77
		Hatchery-reared	425	25	52	37	5	336	23
		Total	1,683	100	183	37	5	1,463	

-continued-

Table 7.–Part 2 of 2.

Year	Weir operating dates	Chinook salmon run: Component	Chinook salmon run: No. fish	Chinook salmon run: %	Egg take mortality (no. Chinook salmon)	Coded-wire-tagged Chinook salmon: No. fish recovered	Coded-wire-tagged Chinook salmon: No. strays detected [a]	Chinook salmon escapement: No. fish [b]	Chinook salmon escapement: %
2004	18 May–5 Aug	Wild	1,525	74	132	NA	NA	1,393	75
		Hatchery-reared	536	26	0	67	1	469	25
		Total	2,061	100	132	67	1	1,862	
2005	6 May–4 Aug	Wild	2,241	83	165	NA	NA	2,076	84
		Hatchery-reared	462	17	0	53	0	409	16
		Total	2,703	100	165	53	0	2,485	
2006	30 Jun–1 Aug	Wild	1,139	81	101	NA	NA	1,038	84
		Hatchery-reared	273	19	35	34	1	204	16
		Total	1,412	100	136	34	1	1,242	
2007	2 Jul–1 Aug	Wild	679	89	129	NA	NA	550	90
	-	Hatchery-reared	83	11	20	0	0	63	10
	-	Total	762	100	149	0	0	613	
2008	30 Jun–7 Aug	Wild	772	88	140	NA	NA	632	90
	-	Hatchery-reared	101	12	30	0	0	70 [g]	10
	-	Total	873	100	170	0	0	702 [g]	
2009	29 Jun–6 Aug	Wild	620	85	38	NA	NA	579 [g]	89
	-	Hatchery-reared	107	15	39	0	0	68	11
	-	Total	727	100	77	0	0	647 [g]	
2010	1 Jul–1 Aug	Wild	623	95	0 [h]	NA	NA	623	95
	-	Hatchery-reared	35	5	0 [h]	0	0	35	5
	-	Total	658	100	0 [h]	0	0	658	100
Averages									
1999–2005		Wild	1,605	73	133	NA	NA	1,472	75
		Hatchery-reared	593	27	28	78	1	487	25
		Total	2,197	100	160	78	1	1,959	
2006–2009		Wild	803	85	102	NA	NA	700	87
		Hatchery-reared	141	15	31	9	0	101	13
		Total	944	100	133	9	0	801	100

Source: Balland and Begich 2007; Begich 2006, 2007; Booz and Kerkvliet 2011a, 2011b, 2011c, 2012; Kerkvliet 2008; Kerkvliet and Booz 2010

Note: "NL" means no data located; "ND" means no data; an endash means the value cannot be computed due to limitations of the data; "NA" means not applicable.

[a] Number of Chinook salmon strays from other drainages that were recovered in the Ninilchik River.

[b] Escapement equals weir count minus the sum of the egg-take mortality and the CWTs recovered.

[c] Because the numbers of wild and hatchery Chinook salmon used in the egg take are unavailable, the numbers of each in the escapement could not be determined.

[d] The numbers of wild and hatchery Chinook salmon in the total are not available.

[e] Run includes the 31 wild and 38 hatchery-reared Chinook salmon that were captured in nets below the weir.

[f] Number of hatchery-reared Chinook salmon in the weir counts were calculated by expansion of fish with CWTs.

[g] Escapement was adjusted by subtracting fish that died in the live box.

[h] No egg takes were conducted in 2010.

Table 8.–Number and escapement of wild and hatchery-reared Chinook salmon counted at the Ninilchik River weir during SEG index monitoring period, 1999–2010.

	Wild Chinook salmon				Hatchery Chinook salmon			
		SEG period [a]				SEG period [a]		
Year	Total run	Weir counts [b]	Escapement counts [c]	Escapement percentage of run	Total run	Weir counts [b]	Escapement counts [c]	Escapement percentage of run
1999	1,576	1,351	1,283	81	573	515	447	78
2000	1,553	1,346	1,265	81	685	786	618	90
2001	1,239	1,072	897	72	543	601	471	87
2002	1,340	1,073	897	67	395	403	238	60
2003	1,127	648	517	46	336	293	204	61
2004	1,393	811	679	49	469	409	342	73
2005	2,076	1,424	1,259	61	409	339	286	70
2006	ND	1,114	1,013	ND	ND	260	191	ND
2007	ND	672	543	ND	ND	83	63	ND
2008	ND	721	586	ND	ND	83	62	ND
2009	ND	551	528	ND	ND	97	69	ND
2010[d]	ND	605	605	ND	ND	34	34	ND
Averages								
1999–2005	1,472	1,104	971	65	487	478	372	74
2006–2009		765	668			131	96	

Source: Balland and Begich 2007; Begich 2006, 2007; Booz and Kerkvliet 2011a, 2011b, 2011c, 2012; Kerkvliet 2008; Kerkvliet and Booz 2010.

Note: "ND" means no data.

[a] SEG is the sustainable escapement goal established in 2007 based on escapement counts from 3 to 31 July, 1999–2007.

[b] Weir counts are the number of Chinook salmon that arrive to the weir during the SEG period.

[c] Escapement counts equal weir counts minus the sum of number scarified for egg take plus CWTs recovered.

[d] No egg takes were conducted in 2010.

Table 9.–Summary of nontargeted species captured at the Ninilchik River weir, 1999–2010.

	Species					
Year	Dolly Varden	Pink salmon	Chum salmon	Sockeye salmon	Coho salmon	Steelhead trout
1999	0	0	0	300	0	0
2000	134	31	0	0	0	0
2001	309	369	0	707	20	0
2002	723	21	12	150	18	0
2003	175	101	2	19	15	0
2004	181	27	9	16	0	2
2005	429	275	4	45	14	1
2006	435	68	12	9	9	2
2007	201	35	14	1	3	1
2008	135	28	4	14	80	1
2009	359	1,118	0	13	31	2
2010	2	1	0	7	1	0
Averages						
1999–2005	279	118	4	177	10	0
2006–2009	283	312	8	9	31	2

Source: Balland and Begich 2007; Begich 2006, 2007; Booz and Kerkvliet 2011a, 2011b, 2011c, 2012; Kerkvliet 2008; Kerkvliet and Booz 2010.

Table 10.–Average, maximum, and minimum water temperature, discharge and stage height for Ninilchik River during the SEG index monitoring period, 3–31 July, 1999–2010.

	SEG counting period								
	River temperature (°C)			Discharge (ft^3/s)			Stage height (ft)		
Year	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.
1999	ND	ND	ND	63	101	52	ND	ND	ND
2000	12	19	9	97	199	59	ND	ND	ND
2001	13	17	10	101	197	58	ND	ND	ND
2002	14	18	11	64	115	46	ND	ND	ND
2003	15	20	11	66	129	54	ND	ND	ND
2004	14	19	10	71	106	54	3.17	3.45	3.00
2005	14	19	11	72	99	60	3.18	3.40	3.07
2006	12	16	9	84	113	73	3.30	3.50	3.20
2007	12	17	9	73	99	58	3.19	3.40	3.05
2008	11	17	8	130	336	68	3.53	4.45	3.15
2009	14	17	10	85	110	71	3.30	3.48	3.18
2010	12	17	8	107	229	71	3.44	4.08	3.18
1999–2009									
Average	13	18	10	82	146	59	3.28	3.61	3.11
Minimum	11	16	8	63	99	46	3.17	3.40	3.00
Maximum	15	20	11	130	336	73	3.53	4.45	3.20

Source: Temperature data collected at the NR-2 site by Sue Mauger of Cook Inletkeeper; provisional discharge data collected by the National Weather Service Alaska Pacific Weather Forecast Center.

Note: "ND" means no data.

Table 11.–Estimated sex and ocean age composition and length-at-age of wild and hatchery-reared Chinook salmon run at Ninilchik River weir, 2010.

	Wild							Hatchery						
		Ocean age					Sex		Ocean age					
	UR [a]	1	2	3	4	Total	composition [b]	UR [a]	1	2	3	4	Total	composition
Females														
Number sampled [c]	3	0	0	23	5	31	158	1	0	1	5	1	8	8
Estimated percent		0.0	0.0	21.2	4.6	25.8	25.8		0.0	3.3	16.3	3.3	22.9	22.9
SE percent		0.0	0.0	1.7	1.7		0.2		0.0	1.2	1.5	1.2		0.0
Estimated abundance [d]		0	0	132	29	161			0	1	6	1	8	
SE abundance		0.0	0.0	10.8	10.8	1.4			0.0	0.4	0.5	0.4	0.0	
Mean length		NA	NA	757	823	769			NA	685	760	760	746	
SE length		NA	NA	7.1	21.9	6.9			NA	NA	23.3	NA	0.0	
Males														
Number sampled [c]	10	4	50	17	0	81	455	4	6	13	4	0	27	27
Estimated percent		4.2	52.2	17.8	0.0	74.2	74.2		20.1	43.6	13.4	0.0	77.1	77.1
SE percent		1.9	3.7	3.5	0.0		0.2		2.8	3.1	2.4	0.0		0.0
Estimated abundance [d]		26	325	111	0	462			7	15	5	0	27	
SE abundance		11.7	23.2	21.7	0.0	1.4			1.0	1.1	0.8	0.0	0.0	
Mean length		465	622	769	NA	649			496	633	758	NA	606	
SE length		34.2	8.1	12.5	NA	9.5			41.3	16.5	40.9	NA	0.0	
Total														
Number sampled [c]	13	4	50	40	5	112		5	6	14	9	1	35	
Estimated percent		4.2	52.2	39.0	4.6	100.0			20.1	46.9	29.7	3.3		
SE percent		1.9	3.7	3.9	1.7				2.8	3.3	2.8	1.2		
Estimated abundance [d]		26	325	243	29	623			7	16	10	1	35	
SE abundance		11.7	23.2	24.2	10.8				1.0	1.2	1.0	0.4		
Jacks counted		47							5					
Mean length		465	634	762	823	684			496	636	759	760	638	
SE length		34.2	8.1	6.7	21.9	9.4			41.3	15.7	20.7	NA	20.0	

[a] "UR" means unreadable scale samples.

[b] All Chinook salmon were examined to identify sex but it was not determined for 9 wild Chinook salmon.

[c] Numbered sampled for age and length data.

[d] Estimated abundances were calculated using the rounded estimated percent presented in this table.

Table 12.–Harvest and catch of Ninilchik River wild and hatchery-reared Chinook salmon reported in freshwater sport fish guide logbooks for regulatory 3-day weekend and July fisheries, 2010.

				Harvest					Catch				
				Wild		Hatchery-reared			Wild		Hatchery-reared		
Fishery	Period	Dates	Angler-days	Number	Percent	Number	Percent	SE [a]	Number	Percent	Number	Percent	SE [a]
3-day weekends	1	29–31 May	16	6	100.0	0	0.0	NA	10	100.0	0	0.0	NA
	2	6–7 Jun	12	1	100.0	0	0.0	NA	1	100.0	0	0.0	NA
	3	12–14 Jun	6	0	100.0	0	0.0	NA	1	100.0	0	0.0	NA
		Overall	34	7	100.0	0	0.0	NA	12	100.0	0	0.0	NA
July [b]	4-Day	1–4 Jul	37	0	0.0	9	100.0	0.0	41	77.4	12	22.6	5.8
	4-Day	5–8 Jul	7	0	0.0	1	100.0	0.0	9	75.0	3	25.0	13.1
		Overall	44	0	0.0	10	100.0	0.0	50	76.9	15	23.1	5.3
Combined			78	7	41.2	10	58.8	5.3	62	80.5	15	19.5	4.5

[a] Binomial proportion; the calculated standard error applies for both wild and hatchery percentages.

[b] Closed to the harvest of wild Chinook salmon.

Table 13.–Estimated annual ocean age composition (percent) for wild and hatchery-reared Chinook salmon from the Ninilchik River, 1997–2010.

	Wild				Hatchery			
	Ocean age				Ocean age			
Year	1	2	3	4	1	2	3	4
1997	0.9	9.1	85.5	4.5	12.2	34.5	45.0	8.3
1998	1.5	33.5	36.1	28.9	7.8	29.8	53.9	8.5
1999	0.0	36.4	46.7	16.9	2.5	53.5	33.8	10.2
2000	2.3	10.5	59.3	27.9	4.6	26.7	60.8	7.9
2001	0.9	40.6	41.5	17.0	8.1	41.4	37.9	12.6
2002	3.0	39.1	52.3	5.6	19.4	33.0	46.6	1.0
2003	1.1	26.9	60.0	12.0	9.7	41.7	47.2	1.4
2004	0.0	21.0	50.3	28.7	1.8	31.9	62.8	3.5
2005	6.2	18.2	68.2	7.4	13.0	12.2	67.5	7.3
2006	9.3	30.0	40.0	20.7	32.8	32.8	22.3	11.9
2007	6.1	24.2	54.5	15.2	26.3	31.6	42.1	0.0
2008	3.4	22.6	62.9	11.1	16.6	34.5	45.8	3.1
2009	20.7	44.3	30.9	4.1	58.4	19.6	21.1	0.9
2010	4.2	52.2	39.0	4.6	20.1	46.9	29.7	3.3
Average								
1997–2009	4.3	27.4	52.9	15.4	16.4	32.6	45.1	5.9

Source: Balland and Begich 2007; Begich 2006, 2007; Booz and Kerkvliet 2011a, 2011b, 2011c, 2012; Kerkvliet 2008; Kerkvliet and Booz 2010

FIGURES

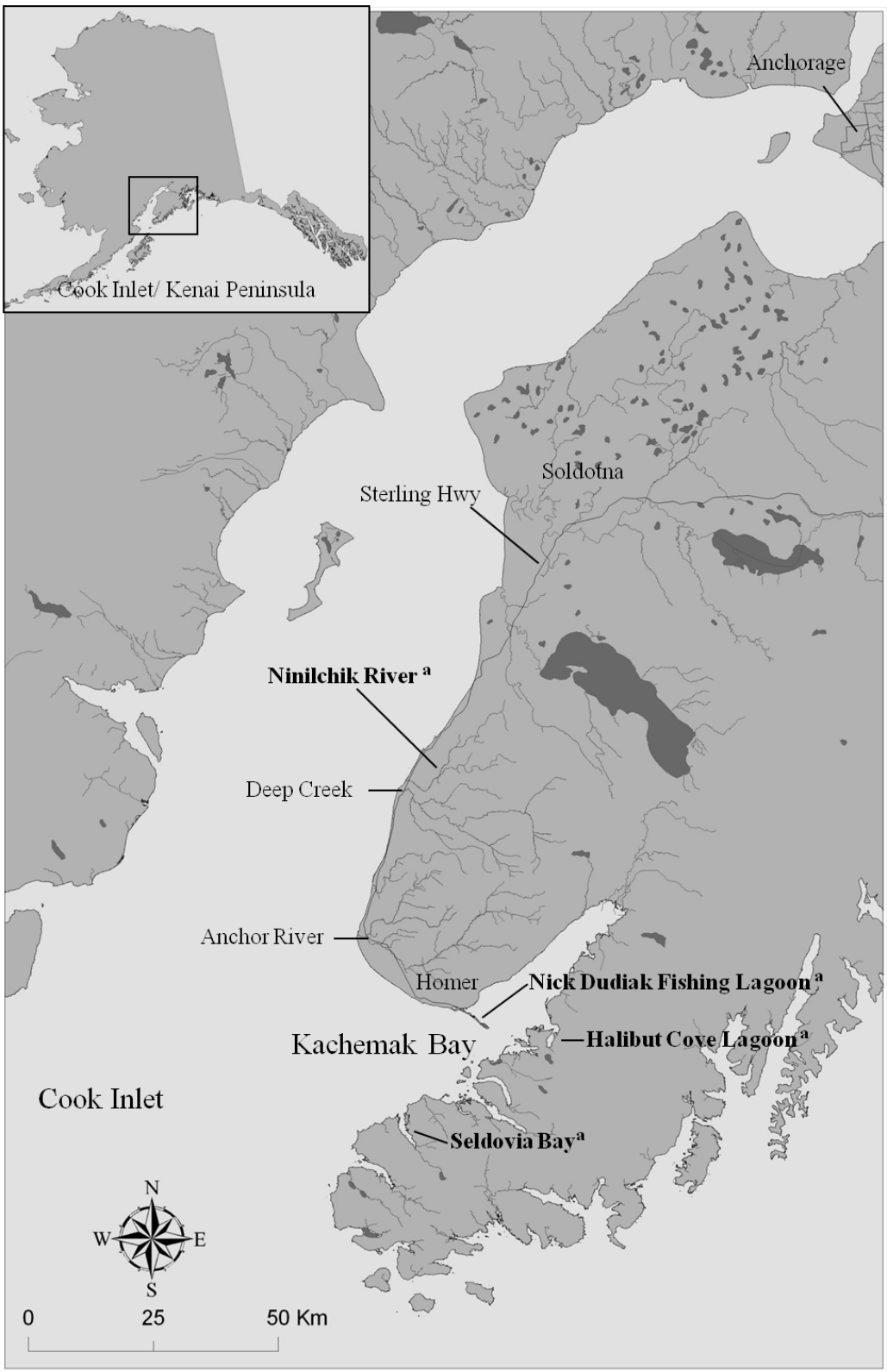

Figure 1.–Map of Kenai Peninsula highway system, Ninilchik River and Kachemak Bay Chinook salmon stocking locations, 1999–2010.

[a] Stocking locations for Ninilchik River Chinook salmon broodstock.

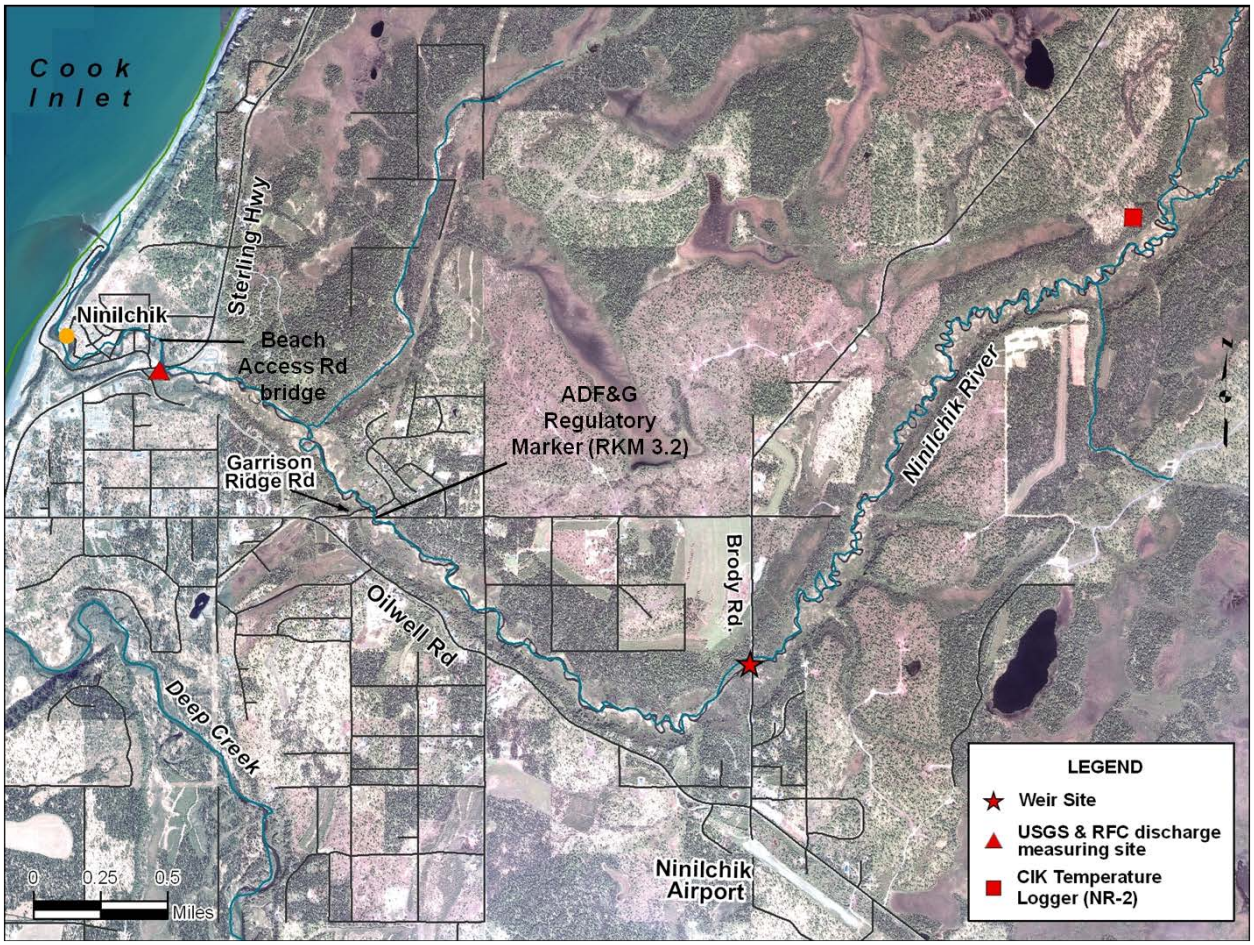

Figure 2.–Map of Ninilchik River sampling locations, 2010.

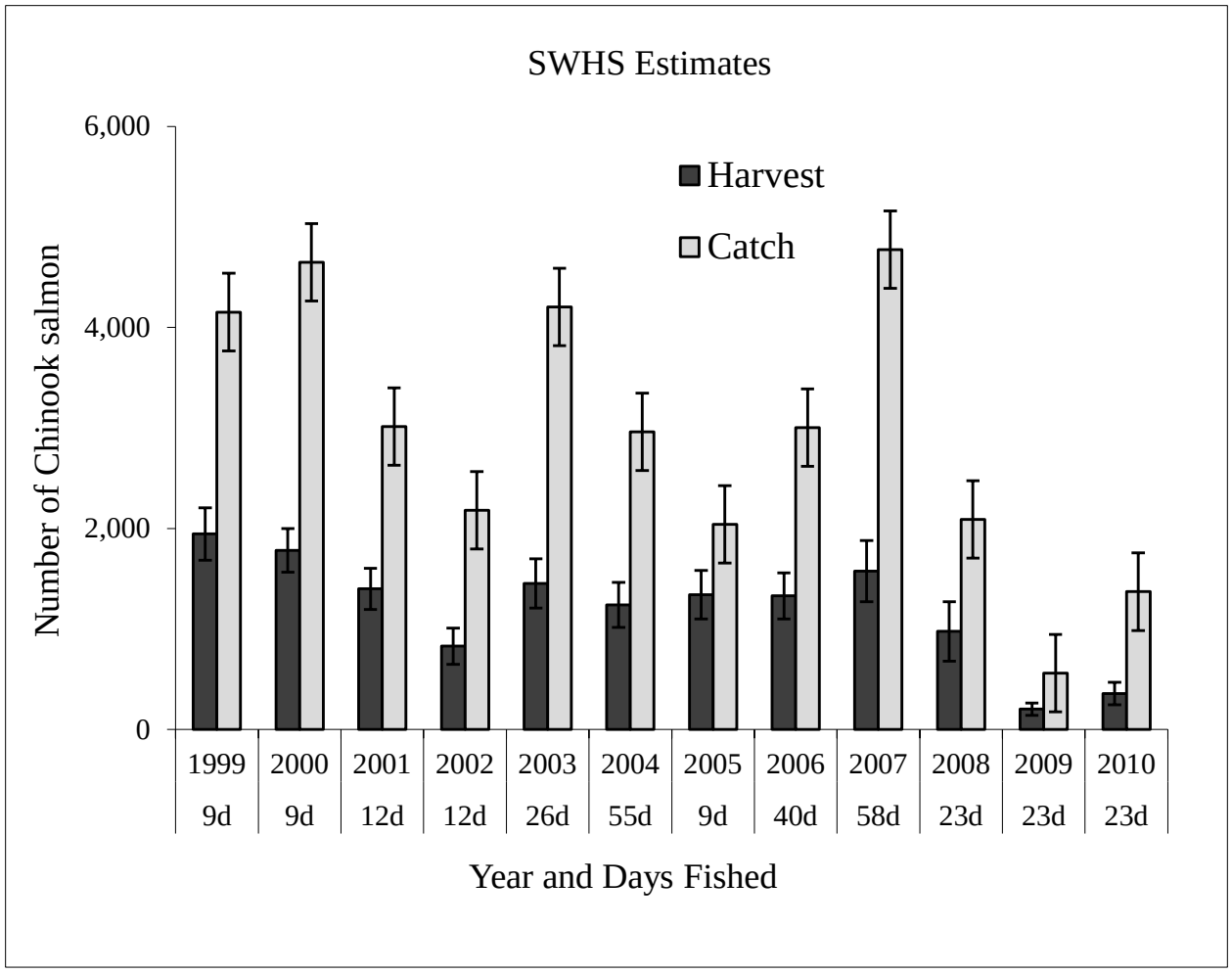

Figure 3.–Statewide harvest survey estimates of catch and harvest of Chinook salmon and number of angler-days fished per year in the Ninilchik River, 1999–2010.

Source: Statewide harvest survey estimates gathered from the published reports for each year. Alaska Sport Fishing Survey database [Internet]. 1996– . Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish. Available from: http://www.adfg.alaska.gov/sf/sportfishingsurvey/.

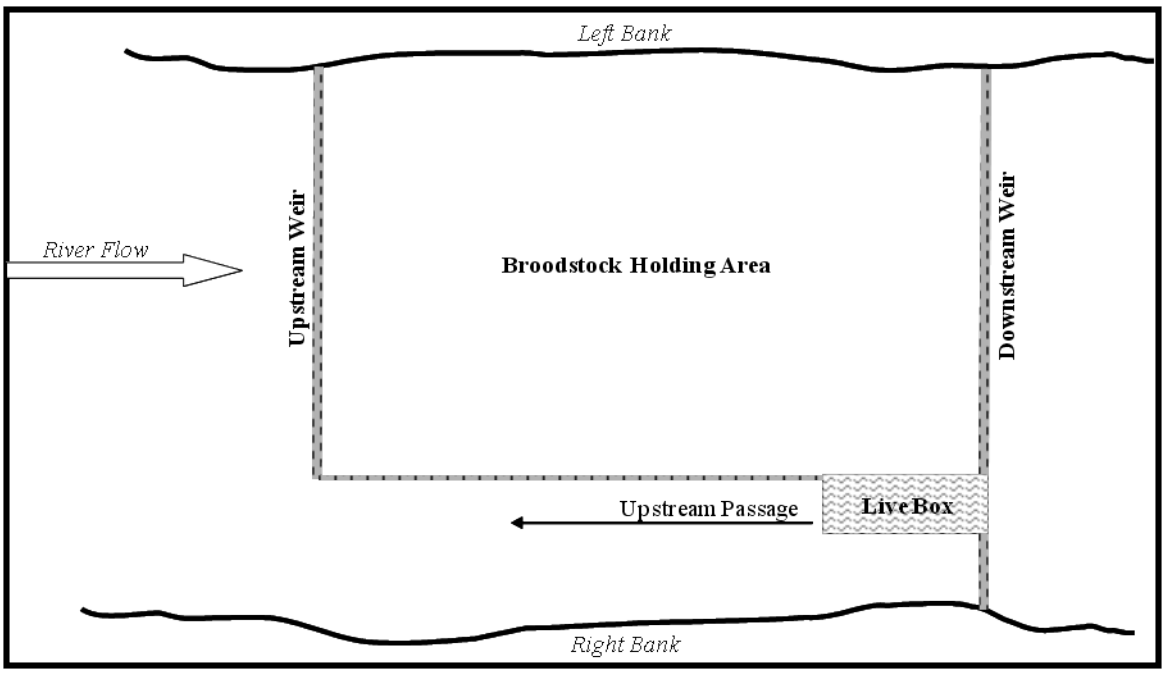

Figure 4.–The configuration of the Ninilchik River weirs and location of the broodstock holding area, 2010.

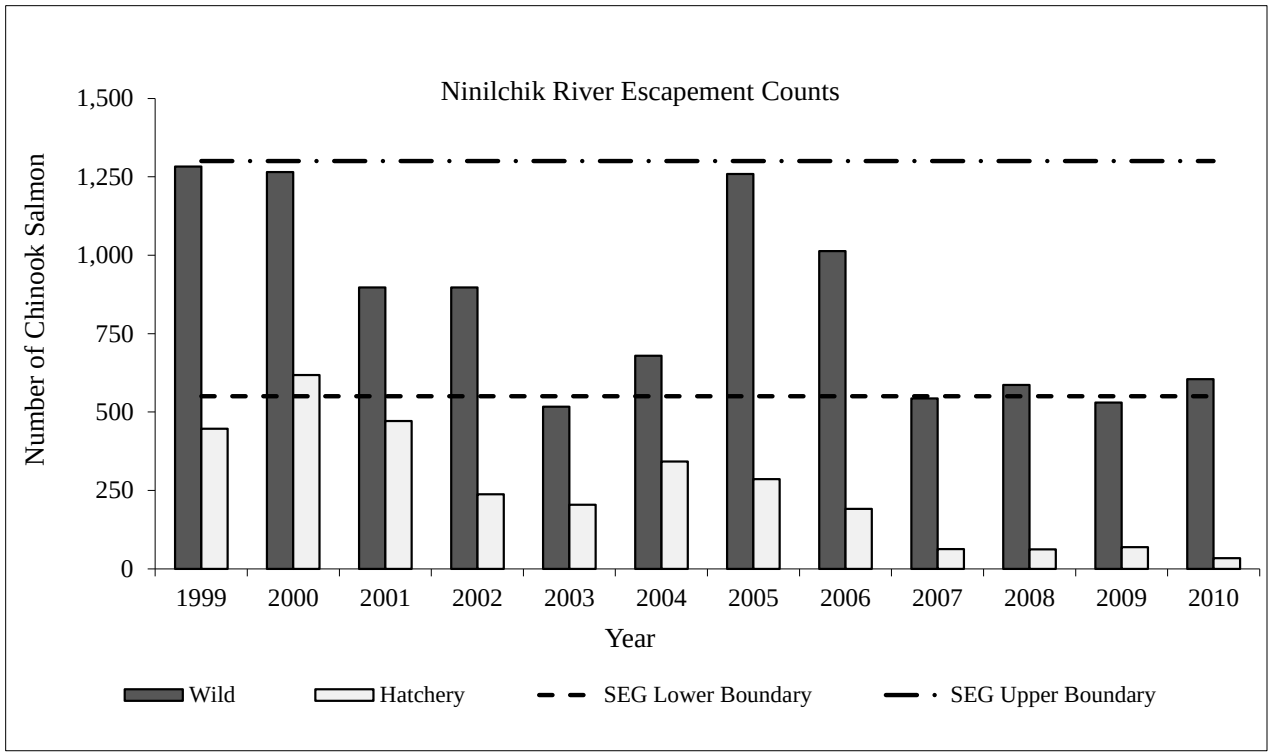

Figure 5.–Ninilchik River Chinook salmon escapement counts during the current sustainable escapement goal (SEG) index monitoring period (3–31 July) with the upper and lower boundaries of the SEG range, 1999–2010.

Source: Balland and Begich 2007; Begich 2006, 2007; Booz and Kerkvliet 2011a, 2011b, 2011c, 2012; Kerkvliet 2008; Kerkvliet and Booz 2010.

Note: Escapement for each year is shown relative to the current SEG established in 2008. Years prior to 2008 were managed with a different SEG.

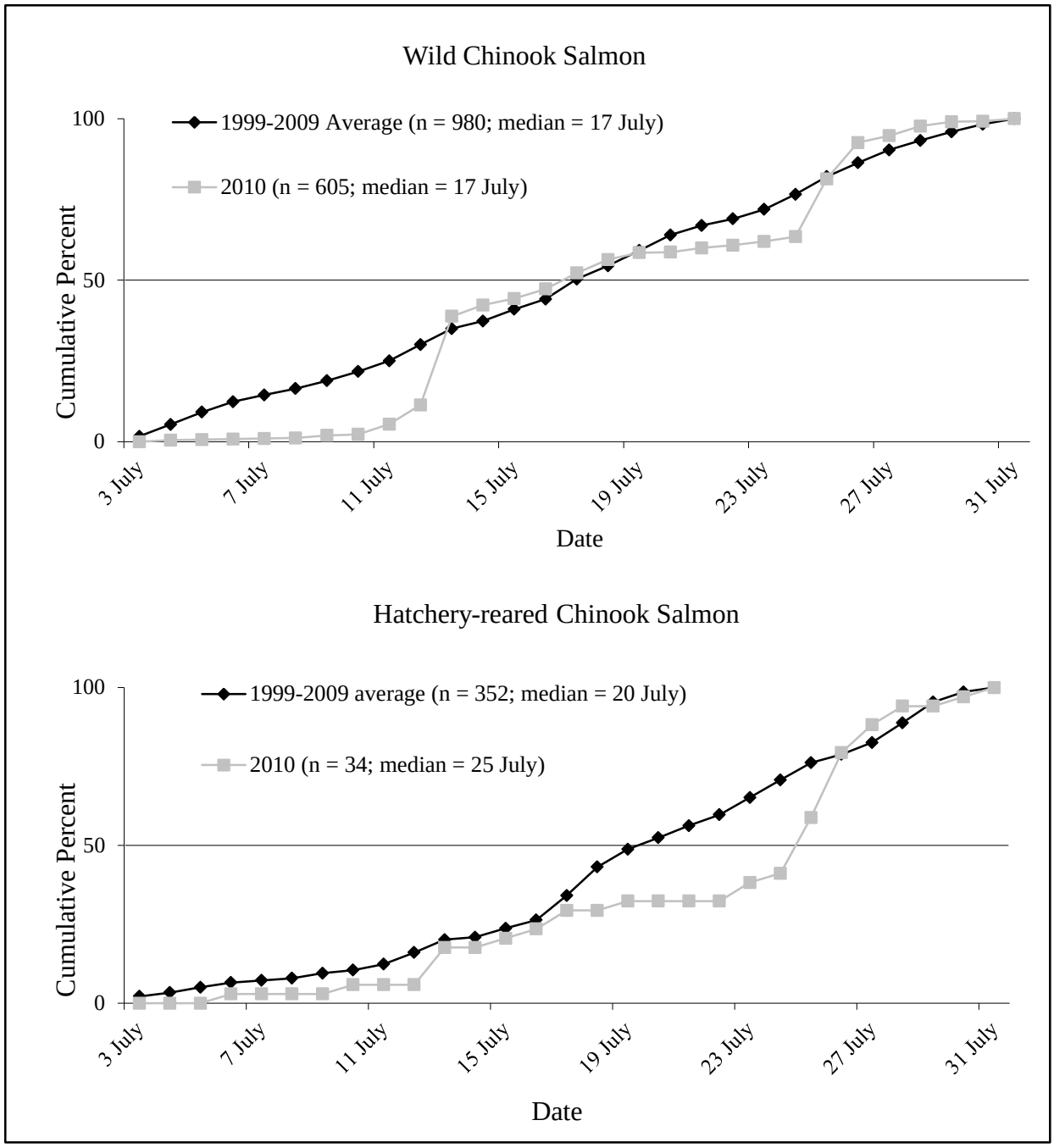

Figure 6.–SEG run timing cumulative percent of wild and hatchery-reared components of the Chinook salmon weir counts during the SEG index monitoring period, 1999–2009 average and 2010.

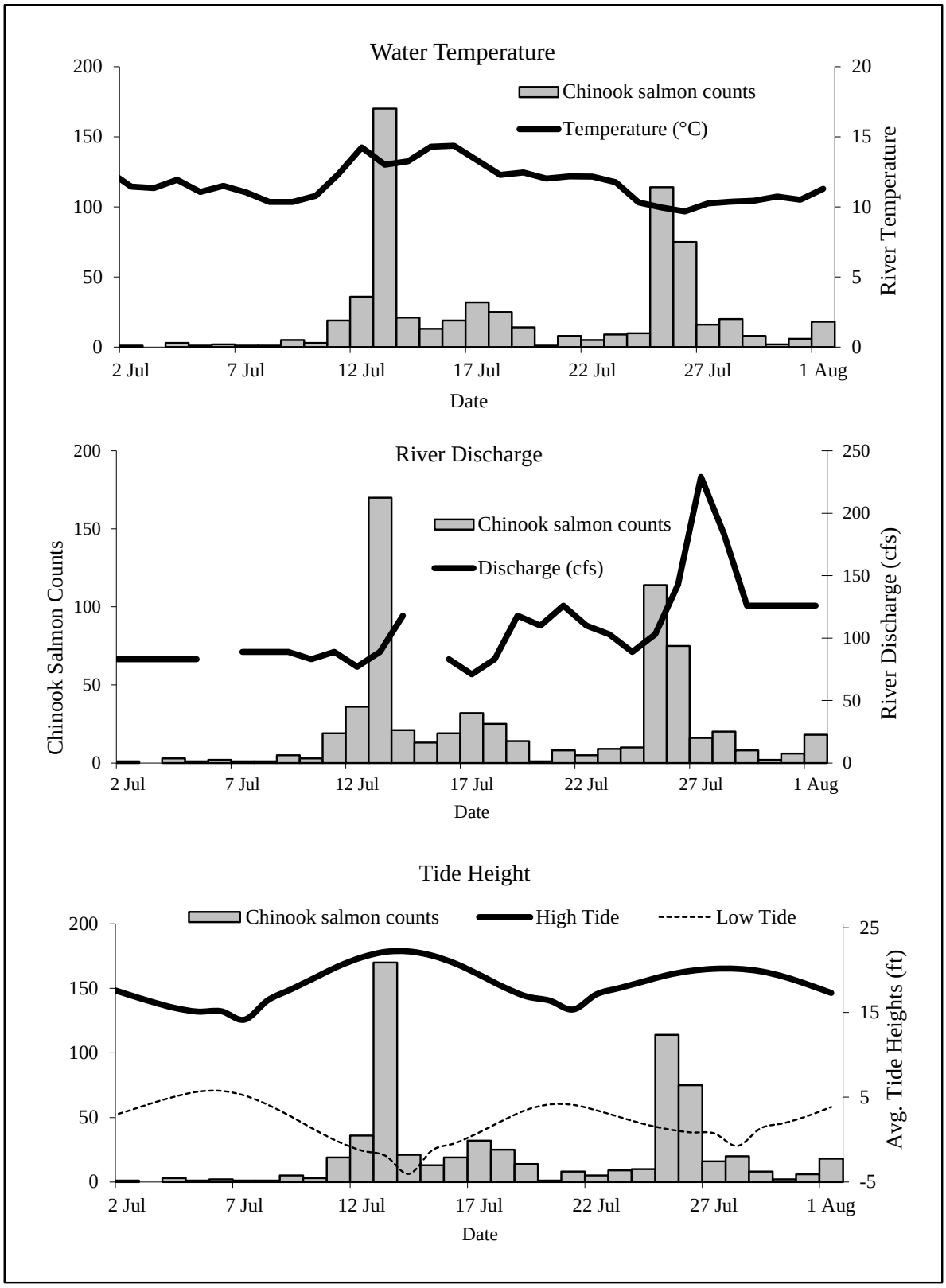

Figure 7.–Ninilchik River Chinook salmon weir counts and average water temperature, discharge, and tide height, 2 July–1 August, 2010.

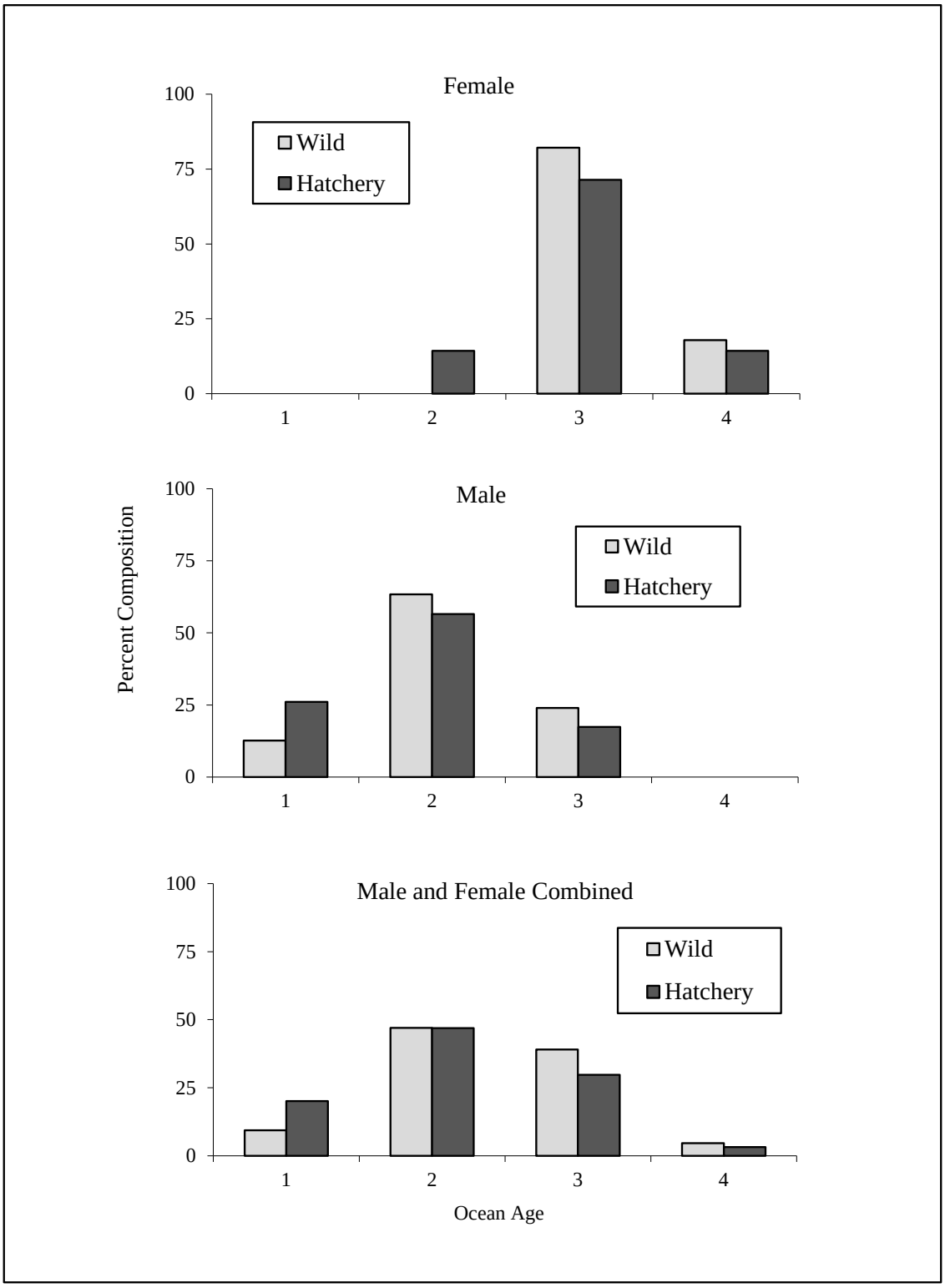

Figure 8.–Estimated ocean-age composition of Ninilchik River wild and hatchery-reared Chinook salmon, 2010.

APPENDIX A: TIMELINES FOR NINILCHIK RIVER CHINOOK SALMON SUPPLEMENTATION AND MONITORING PROGRAM

Appendix A1.–Ninilchik River Chinook salmon supplementation program timeline.

Year(s)	Supplementation
1987	Supplementation program was initiated with Ninilchik River Chinook salmon. Site was selected at river kilometer (RKM) 7.7 (Brody Road Bridge) upstream from the mouth of Ninilchik River for first egg take. The site was selected because of the availability of spawning Chinook salmon and it was accessible by road. Nets were used to capture Chinook salmon for egg takes. Fertilized eggs were transported to the hatchery and reared to smolt.
1988	Egg take was conducted in similar fashion to 1987. First year smolt were stocked into the Ninilchik River (~20% were adipose finclipped and coded-wire-tagged). All smolt were released in the harbor.
1989	Broodstock weir began operating only in July at Garrison Road Bridge (~3 RKM) to capture Chinook salmon for egg takes; a seine was used to encourage fish to move upstream into the trap. A containment area was also created to hold fish so they could ripen. Fertilized eggs were transported to the hatchery and reared to smolt. Smolt were released and the quantity split equally between Brody Road Bridge and Sterling Highway Bridge.
1990–1992	Broodstock weir was moved upstream to Brody Road Bridge (RKM 7.7) and operated only in July. A containment area was also created to hold fish so they could ripen. All smolt were released at Brody Road Bridge.
1993–1994	Genetic policy enacted to require that 60 wild pairs be spawned for Ninilchik River stocking. Wild and hatchery-reared fish were separated for egg take. Broodstock weir, egg takes, and stocking were conducted similar to 1990. All smolt were released at Brody Road bridge.
1995–1998	Beginning in 1995, Ninilchik River stocking rate was reduced to about 50,000 smolt, and the coded-wire-tag (CWT) rate was increased to 100%. In 1995 and 1996, smolt were released in the harbor, thereafter all Ninilchik River smolt were released at Brody Road Bridge. Program was expanded to use smolt from Ninilchik River to support terminal saltwater fisheries in Kachemak Bay. Broodstock weir and egg takes were conducted similar to 1990.
1999–2010	100% of adult hatchery-reared Chinook salmon observed at the broodstock weir were visually identified by an adipose finclip. Broodstock weir was operated throughout the entire run with a holding area only established in July. Egg takes used hatchery-reared fish for saltwater stocking locations. Stocking was conducted similar to 1995. All Ninilchik River smolt were released at Brody Road Bridge.

Appendix A2.–Ninilchik River Chinook salmon escapement monitoring timeline.

Year(s)	Escapement monitoring
1962–1973	Annual Chinook salmon escapement was estimated with a combination aerial and ground index survey. Surveys were conducted once annually over a standard length of river. Aerial surveys were done from a fixed-wing aircraft (super cub). Foot surveys were conducted in only a subsection from the Sterling Highway Bridge upstream approximately 9 RKM (upstream of Brody Road). If the foot survey counts were greater than the aerial counts in the subsection, the total aerial count was expanded by the difference. No surveys were conducted for several years due to poor viewing conditions.
1974	Aerial survey was conducted with both fixed and rotary wing aircraft. Escapement estimate was produced in similar fashion to 1962–1973.
1976–1988	Subsection for ground survey was reduced to 7.7 RKM above mouth at Brody Road Bridge. Escapement estimate was produced in a similar fashion to 1962–1973.
1975	Rotary-wing aircraft replaced fixed-wing aircraft as the viewing platform for all aerial surveys. Escapement estimate was produced in a similar fashion to 1962–1973.
1989	In addition to the aerial and foot survey, escapement data were opportunistically collected from broodstock weir located at Garrison Road Bridge (approximately 3 RKM). Weir was not operated over the entire run.
1990–1993	In addition to the aerial and foot survey, escapement data were opportunistically collected from broodstock weir located at Brody Road Bridge. No attempt was made to identify and enumerate hatchery-reared fish. Weir was not operated over the entire run.
1994	In addition to the aerial and foot survey, escapement counts at broodstock weir were used to estimate the number of wild and hatchery-reared Chinook salmon. The annual estimate of hatchery-reared Chinook salmon was based on the percentage of adipose finclipped fish counted at the weir, the percentage of each brood year detected at the weir through CWT recoveries, and the percentage that each brood year was adipose finclipped. Wild counts equaled the difference between the total number of Chinook salmon counted at the broodstock weir and the hatchery-reared estimate. Weir was not operated over the entire run.
1995–1998	Foot survey was discontinued because counts didn't appear to have a relationship to escapement—probably due to poor visibility. Escapement was monitored at the broodstock weir similar to 1994..
1999–2000	In addition to the aerial survey, broodstock weir was operated over the entire Chinook salmon run. First year where 100% of hatchery-reared fish were identified by adipose finclip. Escapement counts of both wild and hatchery-reared fish were enumerated by subtracting fish sacrificed for egg takes and CWT analysis.
2001–2005	Aerial survey was discontinued in 2001 because counts didn't appear to have a relationship to escapement—probably due to poor visibility. Escapement was monitored at broodstock weir similar to 1999.
2006–2010	Weir was operated only during the month of July and early August, not over the total run.

Appendix A3.–Ninilchik River Chinook salmon sport harvest monitoring and escapement goal timelines.

Year(s)	Sport harvest monitoring
1977–present	Alaska Statewide Harvest Survey conducted, producing estimates of total catch and harvest for Chinook salmon in the Ninilchik River.
1991–1993	Creel surveys of freshwater harvest were conducted to estimate the hatchery-reared harvest.
1994–1996, 2000–2003	Inriver harvest sampling was conducted to estimate the percentage of hatchery-reared fish in the harvest.
2006	Inriver harvest sampling was conducted throughout the area open for sport fishing to estimate the percentage of hatchery-reared fish in the harvest.
2007	Beach seine surveys and Floy tagging were conducted throughout the area open for sport fishing to estimate the percentage of hatchery-reared fish in the inriver Chinook salmon run below RKM 3.2.
2008–2010	No additional monitoring of sport harvest has occurred since 2007.

Year(s)	Escapement goals
1993–1997	First escapement goal adopted (Biological Escapement Goal [BEG] = 830 wild Chinook salmon, which was based on average annual aerial and foot survey average counts and expanded estimates from 1966 to 1969 and 1977 to 1991).
1998	BEG range of 500 to 900 wild Chinook salmon was adopted, which was based on historic aerial survey counts and their relationship to the sport harvest.
2001–2006	Escapement goal policy adopted; BEG was replaced with a Sustainable Escapement Goal (SEG) range of 400 to 850 wild Chinook salmon calculated from 7 years (1994–2000) of weir counts collected from 8 July through 24 July.
2007–2010	SEG with a range of 550 to 1,300 wild fish during an index monitoring period (3–31 July). The SEG was calculated using the percentile method[7] and is based on the wild escapement above the weir during the index monitoring period from 1999 through 2007. The SEG period increased the number of monitoring days by 12 at no additional costs.

[7] Bue, B. G., and J. J. Hasbrouck. *Unpublished*. Escapement goal review of salmon stocks of Upper Cook Inlet. Alaska Department of Fish and Game, Report to the Alaska Board of Fisheries, November 2001 (and February 2002), Anchorage.

Appendix A4.–Ninilchik River Chinook salmon freshwater fishing regulation and emergency order timelines.

Year(s)	Chinook salmon fishing regulations[8]
1977	• Harvest recording requirement. • Open period: 4 two-day weekend openings beginning in the last week of May. • Open area: mouth upstream 2 miles. • Season limit: 5 kings from fresh and salt water combined. • Bag and size limit: 1 king salmon 20 in or larger; 10 kings under 20 in.
1978	Open period changed to 3 three-day weekend openings beginning in the last week of May.
1985	Bag and size limit: 1 king salmon 16 in or larger; 10 kings under 16 in.
2001	Bag and size limit: 1 king salmon 20 in or larger; 10 kings under 20 in.
2005	• Bag and size limit: 2 king salmon 20 in or larger, of which only 1 can be wild; 10 kings under 20 in. • A person may not fillet, mutilate, or otherwise disfigure a king salmon in a manner that prevents determination whether the fish is a wild or hatchery-reared fish until the person has stopped fishing in the Ninilchik River drainage for the day and has moved more than 100 yards away from the Ninilchik River.
2008	Extended open season for hatchery-reared fish from 1 July through 31 December.
2010	The hatchery-reared season closure changed from 31 December to 31 October.

Year(s)	Emergency orders (EOs)
1991	• EO added a fourth 3-day weekend (June 15–17). • EO extended the fishery from June 17 through June 24.
1992	EO extended fishery by 10 days.
1993	EO opened the fishery continuously from June 15 through June 28.
1994	EO opened the fishery continuously from June 14 through June 27.
1995	EO extended the fishery by 14 days.
1996	EO 2-KS-1-20-96 extended the king salmon fishery on the Ninilchik River on a continual basis effective 15 June at 12:01 AM through Monday, 24 June at 11:59 PM.
2001	EO 2-KS-7-05-02 opened the Ninilchik River downstream of the regulatory marker for an additional 3-day weekend from 16 June at 12:01 AM to 18 June at 11:59 PM.
2002	EO 2-KS-7-08-02 opened the Ninilchik River from its mouth to the downstream edge of the Sterling Highway Bridge, from Saturday, 15 June at 12:01 AM to Monday, 17 June at 11:59 PM, to sport fishing for hatchery king salmon only. The daily bag and possession limit was 1 fish 20 in or greater in length or 10 fish under 20 in. Only unbaited artificial lures were permitted.

-continued-

[8] Assume regulations are carried forward unless stated otherwise. Chinook salmon may be referred to as "king salmon" or "kings."

Appendix A4.–Part 2 of 2.

Year(s)	Emergency orders (EOs)
2003	EO 2-KS-7-03-03 opened the Ninilchik River from its mouth to the downstream edge of the Sterling Highway Bridge from Saturday, 14 June at 12:01 AM to Monday, 30 June at 11:59 PM to sport fishing for hatchery Chinook salmon only. The daily bag and possession limit was 1 fish 20 in or greater in length and 10 fish under 20 in. Use of only 1 single hook was allowed.
2004	EO 2-KS-7-03-04 opened the Ninilchik River from its mouth upstream to the regulatory marker located approximately 2 miles upstream to fishing for hatchery king salmon 7 days per week. Bait was allowed. Only 1 single hook could be used. A person could not possess a king salmon that had been filleted, headed, mutilated, or otherwise disfigured in a manner that prevented identification of hatchery or wild origin until permanently transported away from the fishing site if the fish was taken from the riverbank. "Fishing site" meant the riverbank where the fish was hooked and removed from the water. The emergency order was effective Saturday, 29 May at 12:01 AM until 31 December at 11:59 PM.
2006	EO 2-KS-7-12-06 opened the Ninilchik River from its mouth to the regulatory markers located approximately 2 miles upstream from Wednesday, 14 June at 12:01 AM to Friday, 14 July at 11:59 PM to fishing for hatchery king salmon. Hatchery king salmon can be recognized by the healed adipose finclip scar. Anglers were prohibited from removing king salmon with an adipose fin from the water and were required to release them immediately. The daily bag and possession limit was 2 hatchery king salmon 20 in or greater in length and 10 hatchery king salmon under 20 in. Fish 20 in or greater in length must be recorded on the back of the fishing license or harvest record card. Bait was allowed. Use of only 1 single hook was allowed.
2007	EO 2-KS-7-06-07 opened the Ninilchik River from its mouth to the regulatory markers located approximately 2 miles upstream from Saturday, 26 May at 12:01 AM to Sunday, 15 July at 11:59 PM, to fishing for hatchery king salmon. The daily bag and possession limit was 2 hatchery king salmon 20 in or greater in length and 10 hatchery king salmon under 20 in. Fish 20 in or greater in length must be recorded on the back of the fishing license or harvest record card. Bait was allowed. Use of only 1 single hook was allowed.
2010	EO 2-KS-7-10-10 prohibited the use of bait in the Anchor River, Deep Creek, and Ninilchik River beginning Saturday, 5 June 2010 at 12:01 AM through 11:59 PM on 30 June 2010.

APPENDIX B: NINILCHIK RIVER CHINOOK SALMON WEIR COUNTS, 2010

Appendix B1.–Daily and cumulative counts of wild and hatchery-reared Chinook salmon at the Ninilchik River weir, 2010.

Date	Wild			Hatchery-reared			Total		
	Daily count	Cumulative		Daily count	Cumulative		Daily count	Cumulative	
		Count	Percent		Count	Percent		Count	Percent
1 Jul	0	0	0	0	0	0	0	0	0
2 Jul	1	1	0	0	0	0	1	1	0
3 Jul [a]	0	1	0	0	0	0	0	1	0
4 Jul [a]	3	4	1	0	0	0	3	4	1
5 Jul [a]	1	5	1	0	0	0	1	5	1
6 Jul [a]	1	6	1	1	1	3	2	7	1
7 Jul [a]	1	7	1	0	1	3	1	8	1
8 Jul [a]	1	8	1	0	1	3	1	9	1
9 Jul [a]	5	13	2	0	1	3	5	14	2
10 Jul [a]	2	15	2	1	2	6	3	17	3
11 Jul [a]	19	34	5	0	2	6	19	36	5
12 Jul [a]	36	70	11	0	2	6	36	72	11
13 Jul [a]	166	236	38	4	6	17	170	242	37
14 Jul [a]	21	257	41	0	6	17	21	263	40
15 Jul [a]	12	269	43	1	7	20	13	276	42
16 Jul [a]	18	287	46	1	8	23	19	295	45
17 Jul [a, b]	30	317	51	2	10	29	32	327	50
18 Jul [a]	25	342	55	0	10	29	25	352	53
19 Jul [a]	13	355	57	1	11	31	14	366	56
20 Jul [a]	1	356	57	0	11	31	1	367	56
21 Jul [a]	8	364	58	0	11	31	8	375	57
22 Jul [a]	5	369	59	0	11	31	5	380	58
23 Jul [a]	7	376	60	2	13	37	9	389	59
24 Jul [a]	9	385	62	1	14	40	10	399	61
25 Jul [a, c]	108	493	79	6	20	57	114	513	78
26 Jul [a]	68	561	90	7	27	77	75	588	89
27 Jul [a]	13	574	92	3	30	86	16	604	92
28 Jul [a]	18	592	95	2	32	91	20	624	95
29 Jul [a]	8	600	96	0	32	91	8	632	96
30 Jul [a]	1	601	96	1	33	94	2	634	96
31 Jul [a]	5	606	97	1	34	97	6	640	97
1 Aug	17	623	100	1	35	100	18	658	100

[a] Sustainable escapement goal (SEG) index monitoring period.

[b] Median run timing date for wild Chinook salmon during the SEG index monitoring period.

[c] Median run timing date for hatchery-reared Chinook salmon during the SEG index monitoring period.

APPENDIX C: NINILCHIK RIVER WATER TEMPERATURE DATA, 2010

Appendix C1.–Ninilchik River daily mean, minimum, and maximum water temperatures, 1 June–30 September, 2010.

	Daily water temperatures (°C)											
	June			July			August			September		
Day	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
1	ND	ND	ND	12.6	11.2	13.6	11.3	10.1	12.9	9.3	7.5	11.1
2	ND	ND	ND	11.4	10.5	12.3	12.3	10.6	14.7	10.6	8.6	13.0
3	ND	ND	ND	11.4	9.6	13.4	12.5	11.4	13.3	10.7	8.6	12.6
4	ND	ND	ND	11.9	10.1	14.2	11.8	11.2	12.5	10.3	9.8	11.2
5	ND	ND	ND	11.1	10.1	11.7	11.7	10.5	13.4	10.6	9.4	12.3
6	ND	ND	ND	11.5	9.9	13.3	11.5	10.7	12.5	10.0	7.9	11.7
7	ND	ND	ND	11.0	10.0	12.0	11.1	10.4	11.6	11.1	9.9	13.0
8	13.3	11.6	14.2	10.4	9.9	10.9	10.4	9.4	11.1	10.3	9.1	11.5
9	11.0	8.2	14.2	10.4	7.6	12.2	10.9	10.1	11.8	9.5	7.5	11.1
10	10.7	8.3	12.8	10.8	10.1	11.6	10.8	10.1	12.0	9.9	7.7	11.8
11	9.6	7.5	11.2	12.3	8.7	16.5	11.8	10.1	14.3	9.3	7.1	11.4
12	10.8	7.2	14.3	14.2	11.2	17.2	11.3	10.3	12.5	9.1	6.7	11.4
13	12.7	9.5	16.0	13.0	12.3	14.7	11.3	10.2	12.2	9.0	6.7	11.1
14	11.7	10.3	13.5	13.3	10.8	16.4	11.6	10.8	12.8	9.0	7.3	10.6
15	10.0	9.5	11.4	14.3	11.6	17.2	11.3	10.4	12.0	8.7	6.8	10.3
16	8.3	7.6	9.6	14.4	11.5	17.4	11.0	10.7	11.4	7.9	5.8	9.6
17	7.8	6.8	8.8	13.3	12.2	15.2	11.2	10.1	12.9	7.9	5.9	9.8
18	8.6	7.1	10.0	12.3	11.7	13.2	11.6	9.3	14.2	8.3	7.1	9.9
19	8.7	7.8	9.8	12.4	11.1	14.6	11.5	8.8	14.2	7.1	5.8	8.5
20	9.9	7.5	12.7	12.0	11.4	13.2	11.7	8.9	14.3	7.7	6.8	8.4
21	10.7	7.9	13.7	12.2	9.5	15.1	10.6	8.8	12.1	8.2	7.1	9.3
22	12.5	10.1	15.4	12.2	10.7	13.9	10.8	9.6	12.2	8.2	7.0	9.3
23	13.1	10.2	16.0	11.8	10.0	13.0	10.9	8.3	13.5	8.1	6.9	9.3
24	12.6	10.4	14.5	10.3	9.8	11.6	11.5	8.6	14.2	6.4	5.2	8.0
25	12.0	10.4	14.1	10.0	9.2	10.9	11.6	8.8	14.2	5.7	4.5	7.2
26	11.7	10.7	13.1	9.7	9.3	10.3	10.9	8.8	12.5	4.5	2.9	5.7
27	11.2	10.5	11.9	10.3	8.8	12.2	11.2	10.3	12.0	3.1	1.5	4.4
28	12.3	10.1	15.6	10.4	9.5	11.1	11.1	10.4	12.1	2.5	1.3	3.7
29	12.5	11.4	13.7	10.4	9.6	11.6	10.5	8.1	13.1	3.9	3.2	4.7
30	13.3	10.8	16.2	10.7	10.1	11.3	10.9	9.3	12.9	4.6	3.6	5.4
31				10.5	9.9	11.2	9.2	8.3	10.8			

Source: Temperature data collected at the NR-2 site by Sue Mauger of Cook Inletkeeper.
Note: "ND" means no data.

APPENDIX D: NINILCHIK RIVER DISCHARGE AND STAGE HEIGHT DATA, 2010

Appendix D1.–Daily discharge measurements calculated from stage height measurements taken approximately 0.9 river kilometers upstream from the mouth of the Ninilchik River, 2010.

	Discharge (ft^3/s)						
Date	April	May	June	July	August	September	October
1	–	346	96	83	126	103	110
2	–	283	–	83	126	96	183
3	–	269	96	83	118	83	229
4	–	269	110	83	–	83	205
5	–	269	103	83	229	–	183
6	143	249	96	–	229	–	143
7	–	–	96	89	229	–	103
8	–	205	96	89	183	–	103
9	–	205	96	89	172	–	103
10	–	205	89	83	143	–	96
11	–	–	89	89	134	–	103
12	–	126	89	77	110	–	96
13	–	126	83	89	103	83	83
14	–	208	83	118	103	77	83
15	–	183	83	–	162	83	61
16	–	183	143	83	134	77	77
17	–	183	143	71	126	77	83
18	89	162	126	83	126	77	89
19	521	162	121	118	103	83	96
20	521	162	172	110	96	83	96
21	381	143	153	126	89	83	96
22	381	134	126	110	89	83	83
23	346	126	103	103	89	77	89
24	314	126	96	89	83	83	89
25	314	126	96	103	77	83	89
26	269	110	89	143	71	71	89
27	346	110	89	229	77	71	89
28	418	103	96	183	77	71	96
29	381	96	96	126	77	77	103
30	381	96	83	126	71	89	83
31		96		126	77		89

Source: Provisional data collected by the National Weather Service Alaska Pacific Weather Forecast Center.

Note: An en dash means the value can't be calculated due to limitations of the data.

Appendix D2.–Stage height measurements taken approximately 0.9 river kilometers upstream from the mouth of the Ninilchik River, 2010.

	Stage height (ft)						
Date	April	May	June	July	August	September	October
1	–	4.48	3.38	3.28	3.58	3.43	3.48
2	–	4.28	–	3.28	3.58	3.38	3.88
3	–	4.23	3.38	3.28	3.53	3.28	4.08
4	–	4.23	3.48	3.28	–	3.28	3.98
5	–	4.23	3.43	3.28	4.08	–	3.88
6	3.68	4.15	3.38	–	4.08	–	3.68
7	–	–	3.38	3.33	4.08	–	3.43
8	–	3.98	3.38	3.33	3.88	–	3.43
9	–	3.98	3.38	3.33	3.83	–	3.43
10	–	3.78	3.33	3.28	3.68	–	3.38
11	–	–	3.33	3.33	3.63	–	3.43
12	–	3.58	3.33	3.23	3.48	–	3.38
13	–	3.38	3.28	3.33	3.43	3.28	3.28
14	–	3.99	3.28	3.53	3.43	3.23	3.28
15	–	3.88	3.28	–	3.78	3.28	3.08
16	–	3.68	3.68	3.28	3.63	3.23	3.23
17	–	3.88	3.68	3.18	3.58	3.23	3.28
18	3.33	3.78	3.58	3.28	3.58	3.23	3.33
19	4.93	3.58	3.55	3.53	3.43	3.28	3.38
20	4.93	3.78	3.83	3.48	3.38	3.28	3.38
21	4.58	3.68	3.73	3.58	3.33	3.28	3.38
22	4.58	3.63	3.58	3.48	3.33	3.28	3.28
23	4.48	3.58	3.43	3.43	3.33	3.23	3.33
24	4.38	3.58	3.38	3.33	3.28	3.28	3.33
25	4.38	3.58	3.38	3.43	3.23	3.28	3.33
26	4.23	3.48	3.33	3.68	3.18	3.18	3.33
27	4.48	3.48	3.33	4.08	3.23	3.18	3.33
28	4.68	3.43	3.38	3.88	3.23	3.18	3.38
29	4.58	3.38	3.38	3.58	3.23	3.23	3.43
30	4.58	3.38	3.28	3.58	3.18	3.33	3.28
31		3.38		3.58	3.23		3.33

Source: Provisional data collected by the National Weather Service Alaska Pacific Weather Forecast Center.
Note: An en dash means the value can't be calculated due to limitations of the data.

APPENDIX E: CAPE NINILCHIK PREDICTED DAILY AVERAGE HIGH AND LOW TIDE HEIGHTS, 2010

Appendix E1.–Cape Ninilchik predicted daily high and low tides heights, 1 May–31 August, 2010.

	Daily Tide Height											
	May						June					
	High			Low			High			Low		
Day	AM	PM	Average	AM	PM	Average	AM	PM	Average	AM	PM	Average
1	20.8	18.5	19.7		-2.7	-2.7	17.9	16.8	17.4	4.0	-0.3	1.9
2	19.5	17.2	18.4	3.1	-1.3	0.9	16.6	16.2	16.4	4.7	1.0	2.9
3	17.9	16.0	17.0	4.3	0.3	2.3	15.3	15.7	15.5	5.3	2.3	3.8
4	16.3	15.0	15.7	5.5	1.9	3.7	14.2	15.5	14.9	5.6	3.6	4.6
5	14.8	14.5	14.7	6.4	3.3	4.9	13.4	15.6	14.5	5.4	4.6	5.0
6	13.8	14.6	14.2	6.8	4.2	5.5	13.2	16.0	14.6	4.8	5.3	5.1
7	13.4	15.2	14.3	6.3	4.5	5.4		13.6	13.6	3.6	5.6	4.6
8		13.8	13.8	5.1	4.5	4.8	16.7	14.5	15.6	2.2	5.4	3.8
9	16.0	14.8	15.4	3.6	4.2	3.9	17.6	15.7	16.7	0.6	5.0	2.8
10	17.1	15.9	16.5	2.0	3.8	2.9	18.6	16.8	17.7	-0.9	4.3	1.7
11	18.1	17.0	17.6	0.4	3.4	1.9	19.6	17.8	18.7	-2.3	3.6	0.7
12	19.1	17.9	18.5	-1.0	3.1	1.1	20.5	18.6	19.6	-3.5	3.0	-0.3
13	20.0	18.5	19.3	-2.1	2.8	0.4	21.1	19.2	20.2	-4.2	2.4	-0.9
14	20.6	18.8	19.7	-3.0	2.7	-0.2	21.3	19.5	20.4	-4.4	2.1	-1.2
15	20.9	18.8	19.9	-3.4	2.8	-0.3	21.0	19.5	20.3		-4.1	-4.1
16	20.7	18.5	19.6	-3.4		-3.4	20.1	19.4	19.8	1.9	-3.2	-0.7
17	20.2	18.0	19.1	3.1	-2.9	0.1	18.9	19.1	19.0	2.0	-1.8	0.1
18	19.3	17.5	18.4	3.5	-2.1	0.7	17.4	18.8	18.1	2.0	-0.1	1.0
19	18.1	17.1	17.6	3.9	-0.9	1.5	16.0	18.6	17.3	2.0	1.6	1.8
20	16.8	17.1	17.0	4.1	0.3	2.2	15.1	18.5	16.8	1.6	3.1	2.4
21	15.8	17.5	16.7	3.8	1.3	2.6	15.0	18.5	16.8	0.9	4.1	2.5
22	15.5	18.2	16.9	2.8	2.0	2.4	15.0	15.6	15.3	-0.1	4.4	2.2
23		16.0	16.0	1.2	2.3	1.8	18.8	16.4	17.6	-1.1	4.3	1.6
24	19.1	16.8	18.0	-0.5	2.4	1.0	19.2	17.3	18.3	-1.9	4.0	1.1
25	19.9	17.7	18.8	-2.0	2.3	0.2	19.5	17.9	18.7	-2.4	3.5	0.6
26	20.5	18.5	19.5	-3.0	2.3	-0.4	19.8	18.4	19.1	-2.6	3.2	0.3
27	20.9	18.9	19.9	-3.6	2.3	-0.7	19.8	18.6	19.2	-2.6	3.0	0.2
28	20.9	19.0	20.0	-3.7	2.5	-0.6	19.7	18.6	19.2	-2.2	3.1	0.5
29	20.6	18.7	19.7	-3.3	2.9	-0.2	19.2	18.4	18.8		-1.6	-1.6
30	19.9	18.2	19.1	-2.5		-2.5	18.5	18.0	18.3	3.2	-0.6	1.3
31	19.0	17.6	18.3	3.4	-1.5	1.0						

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	Daily Tide Height											
	July						August					
	High			Low			High			Low		
Day	AM	PM	Average	AM	PM	Average	AM	PM	Average	AM	PM	Average
1	17.5	17.6	17.6	3.6	0.5	2.1	16.0	17.7	16.9	3.1	3.6	3.4
2	16.3	17.1	16.7	3.9	1.9	2.9	14.6	17.0	15.8	3.6	5.1	4.4
3	15.0	16.7	15.9	4.3	3.3	3.8	13.4	16.5	15.0	4.1	6.5	5.3
4	13.9	16.3	15.1	4.5	4.7	4.6	12.9	16.2	14.6	4.2	7.6	5.9
5	13.1	16.2	14.7	4.5	5.9	5.2	13.5	16.7	15.1	3.4	7.6	5.5
6	13.0	16.4	14.7	3.9	6.7	5.3		14.9	14.9	1.9	6.6	4.3
7		13.7	13.7	2.8	6.7	4.8	18.0	16.7	17.4	0.0	4.9	2.5
8	17.1	14.9	16.0	1.2	6.1	3.7	19.6	18.6	19.1	-1.9	2.9	0.5
9	18.2	16.4	17.3	-0.5	5.0	2.3	21.3	20.4	20.9	-3.5	0.9	-1.3
10	19.5	17.8	18.7	-2.3	3.7	0.7	22.6	21.8	22.2	-4.4	-0.7	-2.6
11	20.8	19.2	20.0	-3.7	2.3	-0.7	23.2	22.8	23.0	-4.5	-1.8	-3.2
12	21.8	20.3	21.1		1.2	1.2	23.0	23.1	23.1	-3.8		-3.8
13	22.3	21.1	21.7	-4.7	0.3	-2.2	22.1	22.8	22.5	-2.2	-2.4	-2.3
14	22.1	21.4	21.8	-5.0	-4.5	-4.8	20.5	21.8	21.2	-1.8	-0.4	-1.1
15	21.2	21.3	21.3	-0.1	-3.3	-1.7	18.4	20.4	19.4	-0.8	1.9	0.6
16	19.8	20.8	20.3	-0.1	-1.6	-0.9	16.4	18.7	17.6	0.6	4.2	2.4
17	18.0	20.0	19.0	0.3	0.5	0.4	14.8	17.2	16.0	2.0	6.1	4.1
18	16.2	19.0	17.6	0.9	2.7	1.8		16.3	16.3	2.8	7.2	5.0
19	14.8	18.1	16.5	1.5	4.6	3.1	14.2	14.9	14.6	2.6	7.0	4.8
20	14.4	17.5	16.0	1.6	5.8	3.7	16.4	16.0	16.2	1.8	6.0	3.9
21		14.9	14.9	1.2	6.1	3.7	17.2	17.2	17.2	0.9	4.8	2.9
22	17.5	15.9	16.7	0.4	5.6	3.0	18.2	18.2	18.2	0.2	3.6	1.9
23	18.0	16.9	17.5	-0.4	4.8	2.2	19.1	19.1	19.1	-0.3	2.5	1.1
24	18.6	17.8	18.2	-1.1	3.9	1.4	19.9	19.9	19.9	-0.6	1.6	0.5
25	19.3	18.6	19.0	-1.5	3.1	0.8	20.3	20.4	20.4	-0.5	1.0	0.3
26	19.8	19.1	19.5	-1.7	2.5	0.4	20.4	20.6	20.5	-0.1	0.8	0.4
27	20.0	19.4	19.7	-1.6	2.2	0.3	20.1	20.5	20.3	0.6	1.6	1.1
28	19.9	19.5	19.7	-1.2		-1.2	19.3	20.0	19.7	0.9	2.9	1.9
29	19.4	19.4	19.4	2.1	-0.3	0.9	18.1	19.4	18.8	1.3	4.3	2.8
30	18.5	19.0	18.8	2.2	0.8	1.5	16.8	18.5	17.7	1.9	5.8	3.9
31	17.3	18.4	17.9	2.6	2.1	2.4	15.3	17.6	16.5	2.7		2.7

Source: Tide and Currents Pro Nobeltec Software.